Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JULY 1961

DETROIT PUBLIC LIBRARY

PORTRAIT OF PROGRESS: *Wean No. 2 Alkaline Tinning Line at Granite City Steel Company's Granite City Works*

Granite City Increases its Range of Tin Plate Widths with New Wean Alkaline Line

To supply the full range of coil widths required by the can manufacturing companies it serves, Granite City Steel Company recently installed this Wean alkaline-type tinning line.

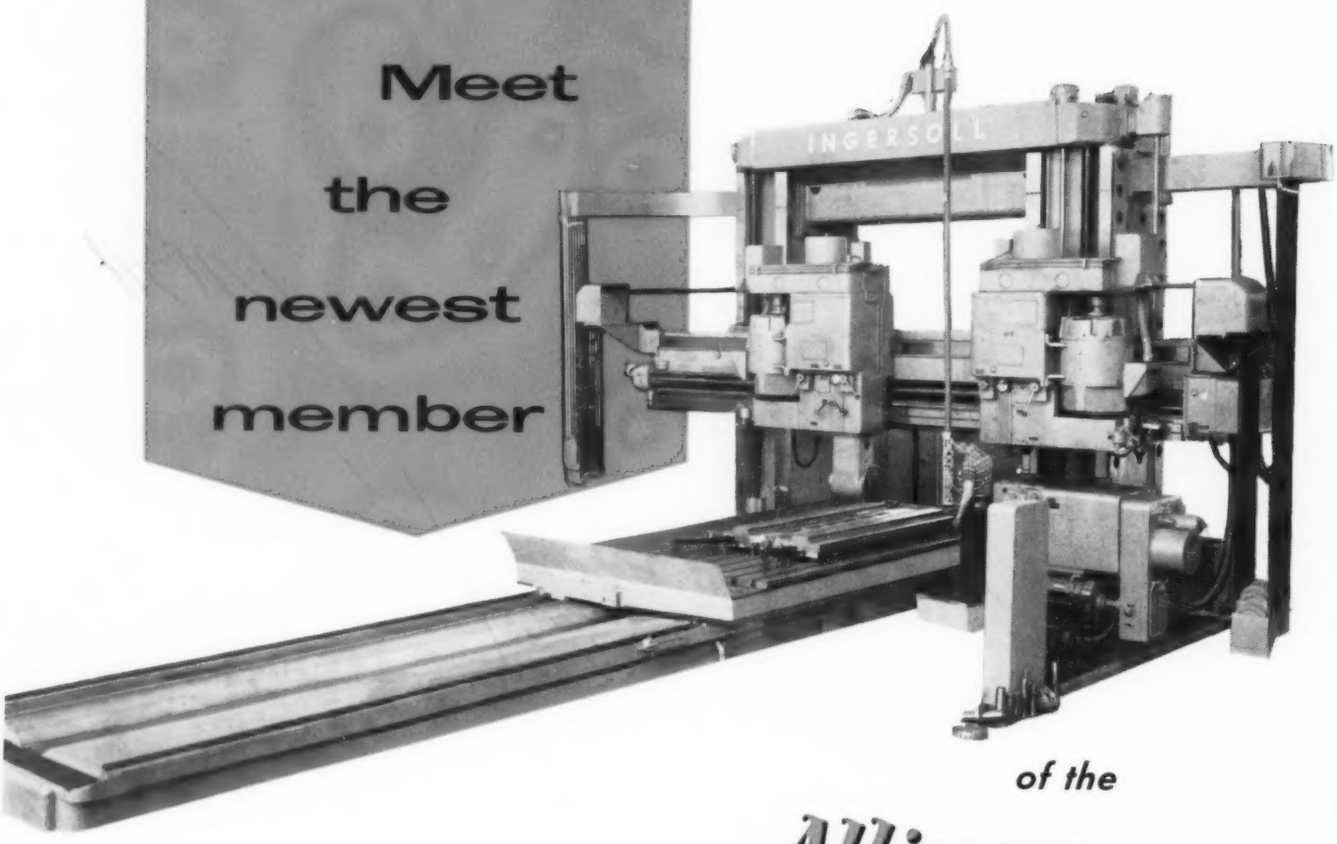
Capable of handling coils up to 40,000 lbs. with an outside diameter of 72", this line is designed to process tin plate at speeds up to 1200 fpm. The line can accommodate strip from 18" to 38" in width and from .003" to .015" in thickness.

The new Wean line has been designed to economically produce differential plating, providing more versatility in meeting customer requirements. Strip storage is provided in looping towers at both the entry and exit sections of the line in order to maintain constant flow of material through the processing section.

During its three-decade partnership with the steel industry, Wean Engineering Company has designed more than 80% of all electrolytic tinning facilities in operation today. We invite you to put this experience to work on your next tinning line project.

THE WEAN ENGINEERING COMPANY, INC. · WARREN, OHIO

Meet the newest member



Ingersoll built this specially designed, adjustable rail milling machine for The Alliance Machine Company. This Ingersoll unit will machine steel fabrications up to 10 ft. wide, 9 ft. high and 30 ft. long.

of the

Alliance family

Top efficiency of production is essential to your ultimate costs and profits.

Creative designing, proper research, skillful engineering and quality workmanship make THE ALLIANCE MACHINE COMPANY the most respected crane manufacturers and "The World's Largest Builders of the World's Largest Cranes".

the Alliance

machine company

Main Office ■ Alliance, Ohio

"Give Us The Runway and We'll Lift The World"

Overhead Cranes ■ Gantry Cranes ■ Mill Cranes and Equipment ■ Hot Metal Cranes ■ Ladle Cranes ■ Stripper Cranes ■ Soaking Pit Cranes ■ Soaking Pit Cover Cranes ■ Charging Machines ■ Furnace Chargers ■ Slab Handling Cranes ■ Bucket Cranes Magnet Cranes ■ Mold Yard Cranes ■ Skull Cracker Cranes ■ Ingot Buggies ■ Run-Out Tables ■ Car Dumpers ■ Special Mill Equipment ■ Ore & Coal Bridges ■ Loading & Unloading Towers ■ Forging Manipulators ■ Forging Cranes ■ Power House & Dam Cranes ■ Dock & Pier Handling Equipment ■ Research, Development & Engineering Service ■ Licensees and Manufacturing Facilities in Other Countries.

The trend toward new products, with emphasis on lightness and strength, puts the night lights back to work.

Lots of man-hours are going into these developments, such as thin tin plate and light wall pipe and tubing. We are contributing more than a few ourselves. We should. We are a major supplier of equipment, and what's good for the industries we serve is good for us.

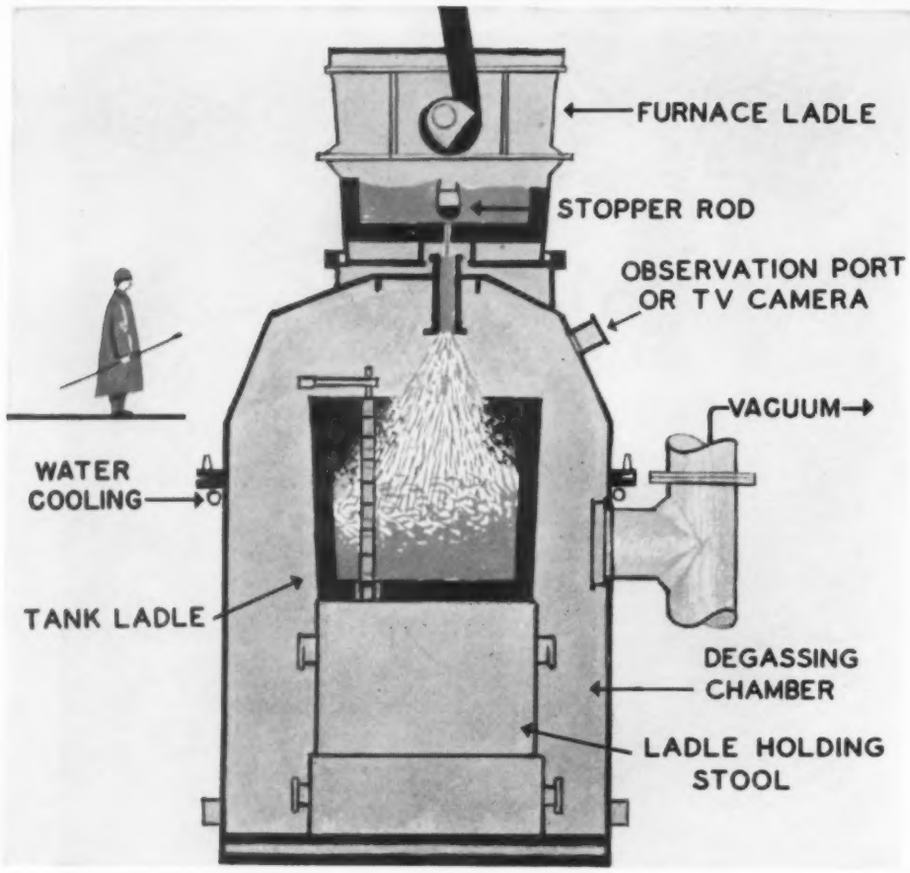
More important, we do have a lot of knowledge and experience to draw on. We have been building equipment for handling and processing sheet and strip, as well as bars, tubes and pipe for a good many years.

300 Sixth Avenue
Pittsburgh 22, Pennsylvania

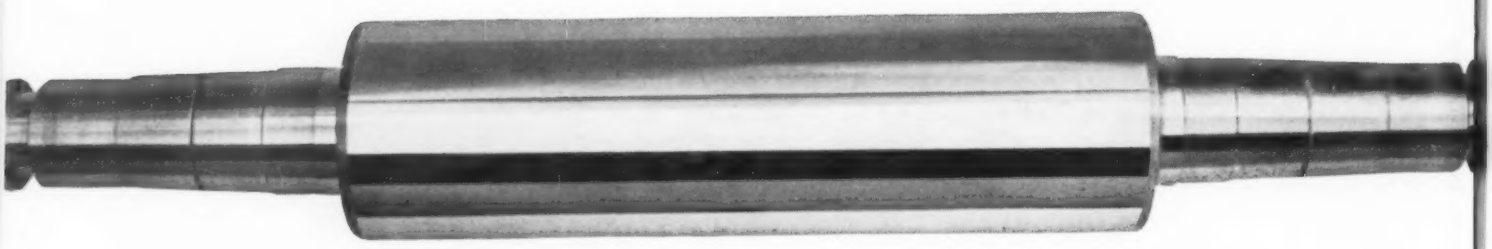
BLAW-KNOX

Aetna-Standard Division
BLAW-KNOX

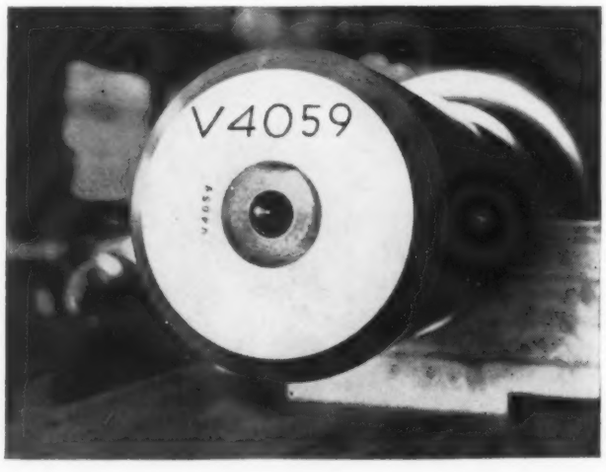
Blaw-Knox designs and manufactures for America's growth industries: METALS: Rolling Mills • Steel Processing Lines • Rolls • Castings • Open Hearth Specialties • PROCESSING: Process Design, Engineering and Plant Construction Services • Process Equipment and Pressure Piping • CONSTRUCTION: Concrete and Bituminous Paving Machines • Concrete Batching Plants and Forms Gratings • AEROSPACE: Fixed and Steerable Antennas • Radio Telescopes Towers and Special Structures • POWER: Power Plant Specialties and Valves



Our advanced steel-pouring techniques now permit us to pour molten steel from a furnace ladle to a secondary ladle within a vacuum chamber, and thereby remove harmful gases. The secondary ladle is then removed from the chamber and ingots of suitable size for hardened steel rolls can be cast under a blanket of inert gas.



When you use Bethlehem vacuum-degassed hardened steel rolls, you add many tons of production per roll. Made from steel that's sounder, tougher, cleaner . . . these rolls have proved their longer service in some of the biggest rolling mills in the country. As of today, there are over 3000 in service. There's no price extra! And deliveries are excellent. For all the money-saving details, get in touch with our nearest sales office.



LOOK FOR THIS "V" STAMP on the ends of the rolls you buy . . . "V" is for vacuum. You'll find this permanent identification on every Bethlehem roll . . . because Bethlehem forges hardened steel rolls **only** from vacuum-degassed steel.

Steel

for Strength
. . . Economy
. . . Versatility

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. *Export Sales:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

T. J. ESS, *Editor*

I. E. MADSEN, *Associate Editor*

W. C. FRIESEL, *Advertising Manager*

T. A. KOCIS, *Production Manager*

Board of Directors

PRESIDENT
C. E. PRITCHARD
General Superintendent of Mills
Alan Wood Steel Co.

FIRST VICE PRESIDENT, H. L. JENTER, *Vice President—Operations,* American Steel and Wire Div., United States Steel Corp.

SECOND VICE PRESIDENT, C. W. BRUCE, *Chief Engineer—Steel Plants,* Republic Steel Corp.

TREASURER, H. R. KNUST, *Assistant Genera Manager,* Sparrows Point, Bethlehem Steel Co.

SECRETARY, N. C. MICHELS, *Vice President—*Facility Planning and Appropriations, United States Steel Corp.

PAST PRESIDENTS: EMIL KERN, *Vice President of Engineering, Allegheny Ludlum Steel Corp.*

S. C. READ, Pittsburgh, Pa.

DIRECTOR-AT-LARGE: H. A. LONG, *General Manager—Operations,* Pittsburgh Steel Co.

DIRECTORS: M. B. ANTRIM, *Manager,* Engineering and Construction Div., Lukens Steel Co.

H. W. DORSET, *Assistant Superintendent—Electrical Dept.,* Sparrows Point, Bethlehem Steel Co.

F. M. FARRAGHER, *Superintendent—Blast Furnace Aux.,* Youngstown, United States Steel Corp.

E. W. FITCH, *Chief Combustion Engineer,* Youngstown, Republic Steel Corp.

J. H. FRANZ, *Superintendent of Operating Maintenance,* Edgar Thomson Works, United States Steel Corp.

R. J. GARMY, *Assistant Chief Engineer,* Canton, Republic Steel Corp.

H. V. GUMMA, *Superintendent—Rolling and Finishing Mills,* Pueblo, The Colorado Fuel and Iron Corp.

R. D. HINDSON, *Assistant Chief Metallurgist,* The Steel Co. of Canada, Ltd.

R. W. HOLMAN, Vice President—Engineering, Tennessee Coal & Iron Div., United States Steel Corp.

R. L. HUMPHREYS, *Assistant Master Mechanic,* Coke Oven Dept., Sparrows Point, Bethlehem Steel Co.

J. R. HUNT, *Chairman Operating Committees,* Tennessee Coal & Iron Div., United States Steel Corp.

B. W. HYDE, *Superintendent—Service and Maintenance,* Laclede Steel Co.

G. S. KOSS, *Assistant Division Superintendent—Rolling Mills,* Columbia-Geneva Steel Div., Provo, United States Steel Corp.

E. O. KRUEGER, *General Foreman—Utilities,* Acme Steel Co.

G. M. KYLE, *Assistant Superintendent—Mechanical* Dept., Inland Steel Co.

J. L. LAIDLAW, *Manager of Engineering and Construction,* Algoma Steel Corp., Ltd.

J. S. MOORE, *Assistant Superintendent—Rolling Mill,* Columbia-Geneva Steel Div., Torrance, United States Steel Corp.

W. L. MURPHY, *Assistant General Manager,* South San Francisco, Bethlehem Steel Co., Pacific Coast Div.

R. C. SCHAEFER, *Assistant Superintendent—Hot Strip, Soaking Pit & Blooming Mill Dept.,* Steubenville, Wheeling Steel Corp.

W. P. SMITH, *Assistant Works Manager,* Cleveland, Jones & Laughlin Steel Corp.

Managing Director
T. J. ESS
Empire Building, Pittsburgh, Pa.

Iron AND Steel ENGINEER

VOLUME XXXVIII • NUMBER VII JULY, 1961

67 Retaining Flexibility in the Design of Mechanized Merchant Bar Mills
by Edward C. Peterson and William H. Boblitz

91 Colorado Fuel and Iron's Basic Oxygen Shop
by George Grosvenor

92 How to Get and Use Rolling Mill Power Data
by A. J. Winchester

99 Tentative Program—1961 AISE Annual Convention

101 Electric Furnace or Cupola, Basic Oxygen Converter for the Nonintegrated Steel Plant
by D. A. Sutch and H. C. Manley

108 Cupola Metal Increases Open Hearth Production
by Wilt H. Steinheider

112 Soaking Pit Expansion and Slabbing Mill Installation at Kaiser Steel's Fontana Plant
by Merle L. Gruver

119 The Automated Blast Furnace—Fact or Fiction?
by J. E. Oram

126 The Venturi Scrubber for Cleaning Oxygen Steel Process Gases
by Howard P. Willet and Daniel E. Pike

132 New Methods of Mounting Crane Rails on Overhead Runways
by A. Gordon Senior

136 First Industrial Process Control Digital Computer in the United Kingdom Programs Billet Shearing

139 Data Logging Supplies Mill Records

141 Tube Mill Welder is Vapor Cooled

142 Magnet Removes Tramp Steel from Roadway

144 Powered Steel-Strapping Equipment Increases Production

147 Structural Innovations Feature New Great Lakes Steel Mill Buildings

148 Square and Rectangular Structural Tubing Produced by National Tube

151 Tar Distillation Plant Started by U. S. Steel

151 Corporacion Venezolana de Guayana to Receive Management Advice from Koppers

DEPARTMENTS

11 Crops and Shorts
19 Patent Reviews
65 Steel Angles
157 Date-line Diary
163 Industry News
183 Personnel News
201 Equipment News
208 Book Reviews
213 Index to Advertisers

Published Monthly by

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

Copyright, 1961, The Association of Iron and Steel Engineers.

Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 (U. S. funds) Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds).....$ 7.50 per year
Subscription price in foreign countries (U. S. funds).....$10.00 per year

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers at 20th and Northampton Sts., Easton, Pa. Editorial and advertising offices, 1010 Empire Bldg., Pittsburgh 22, Pa. Second-class mail privileges authorized at Easton, Pa. This publication is authorized to be mailed at the special rates of postage prescribed by Section 132.122

OPEN UP: for better drawing quality steel

The uniformity of anneal possible only through the Open Coil Process means a more uniform Rockwell with more uniform drawing quality throughout the entire coil. This enables a steel producer to duplicate orders, providing the same steel time after time, so that one stamping plant will be using precisely the same steel as another — an important consideration for decentralized manufacturing. "Stickers" are eliminated, and it is now possible to roll smoother deep-draw steels with better surface qualities for improved end products. For further information write the *Lee Wilson Engineering Co., Inc., 20005 Lake Road, Cleveland 16, Ohio.*

Lee Wilson

Originators and Leading Producers of Open Coil and Single Stack Furnaces

SIEMAG

PROGRESS
IN ROLLING MILL CONSTRUCTION

AW 69—61

For high performance and economic service SIEMAG Rolling Mills

Automatic 2-strand roller type cooling bed, appr. 400 Ft length, arranged behind a continuous bar mill, max. rolling speed 3200 FPM

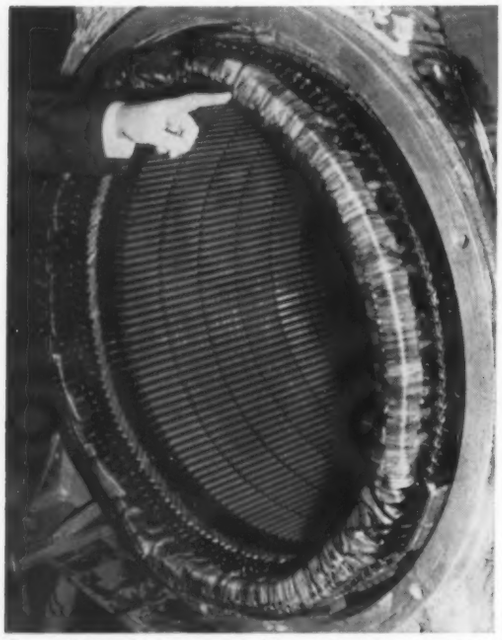
SIEMAG - SIEGENER MASCHINENBAU GMBH - DAHLBRUCH (WESTF.) GERMANY

Telephone Hilchenbach, Kr. Siegen, 841
Düsseldorf Office, Berliner Allee 34-36, Telephone 10091

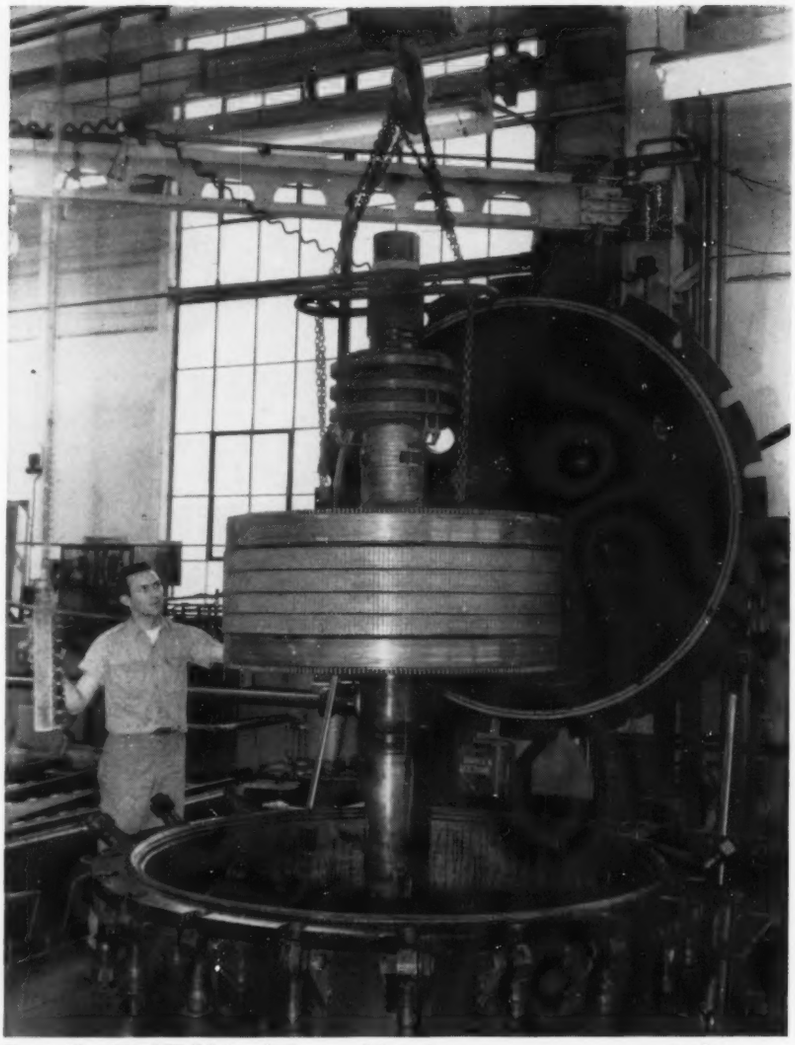
For maximum motor life...

NATIONAL VACUUM-IMPREGNATES THE COMPLETE MOTOR WITH EPOXY

National offers superb facilities for rewinding and rebuilding rotating electrical machines...such as this large vacuum tank used in impregnating insulations with super-strong Epoxy resins. Not only single coils, but complete rotor and stator assemblies for large motors are regularly handled in this equipment.



Complete stator assembly with NECCOBOND insulation system, after vacuum impregnation with Epoxy resins.



Rotor for 750-HP Motor is lowered into huge vacuum-pressure tank.

This process, used with the NECCOBOND insulation system provides these assurances of maximum service life:

- the insulation wall is completely void-free, with all interstices filled with resin to provide maximum heat conductivity.
- the exceptional mechanical strength and adhesion of Epoxy resin bonds the entire winding and core into a solid mass.
- uniform encapsulation provided by National's method of baking, insures high degree of protection against moisture.

Whether your electric coil and rebuilding needs are standard or special, you'll be sure of performance when you call in National Electric Coil. We tailor-make the coils to fit your needs, offer all types of insulation. For information call National's Columbus plant ...HUdson 8-1151... or check the nearest National field engineer.

NATIONAL COILS

National Electric Coil

COLUMBUS 16, OHIO • IN CANADA: ST. JOHNS, QUEBEC

DIVISION OF McGRAW EDISON

One of the Firth Brown roll grinding shops

FORGED STEEL ROLLS

FULLY HARDENED AND SEMI-HARD ROLLS
ARE MADE FROM A FEW LBS.
TO 50 TONS IN WEIGHT

by **Firth Brown**

ATLAS WORKS · SHEFFIELD · ENGLAND

ALLOY STEELMAKERS
FORGEMASTERS
STEEL FOUNDERS
HEAVY ENGINEERS

DAVY-UNITED

AUTOMATIC GAUGE CONTROL

OPERATING IN CANADA

56-inch 4-High Cold Reversing Mill at Dominion Foundries and Steel Limited, Hamilton, Ontario, which is equipped with the Davy-United system of Automatic Gauge Control. This mill rolls steel strip for tin plate between 24 inches and 50 inches wide in a range of thicknesses from .006 inches to .050 inches.

Six Automatic Gauge Control installations have now been completed or ordered in North America and Licensees in North America for the Davy-United system of Automatic Gauge Control include General Electric Company of the U.S.A., Canadian General Electric Company Limited and Canadian Westinghouse Limited.

DAVY-UNITED | DAVY-ASHMORE GROUP

DAVY AND UNITED INSTRUMENTS LIMITED . SHEFFIELD . ENGLAND

LONDON . STOCKTON . GLASGOW . MIDDLESBROUGH . HULL . PARIS . MONTREAL . MELBOURNE . SYDNEY . JOHANNESBURG . SALISBURY . CALCUTTA . BOMBAY

379/DV

LEADOLENE and KLINGFAST

THE *Superior* LUBRICANTS FOR COUPLINGS

Brooks LEADOLENE and KLINGFAST lubricants have been used successfully for years in coupling installations. Under conditions of high torque and misalignment the best in lubrication is required. The lubricant must withstand the severe wiping action and provide positive lubrication. To obtain the optimum in coupling lubrication, the product must have excellent polarity for metal surfaces . . . good flow characteristics . . . extreme pressure . . . resist the throw-off action of centrifugal force.

Years of experience and customer acceptance prove conclusively that LEADOLENE and KLINGFAST are superior lubricants for coupling lubrication.

See the Brooks Oil man near you.

The BROOKS OIL Company
Established 1876

General offices and U.S. plant: 3304 East 87th Street • Cleveland 27, Ohio
Canadian offices and plant: 461 Cumberland Avenue • Hamilton, Ontario

The Brooks Oil International Company: Exporters
OFFICES AND WAREHOUSES IN PRINCIPAL CITIES • U.S.A. • CANADA

RUST-OLEUM.

NEW COLOR

HORIZONS System

STOPS RUST AND PROVIDES LASTING BEAUTY

Gone are the days when color was used for the sake of color alone. Today, color is functional—helping to improve morale and increase efficiency—serving to color-code and mark safety areas, etc. The Rust-Oleum New Color Horizons System goes even further. It combines four important factors (1) the ability to stop rust, (2) smart, modern color harmony, (3) the durability to last and last, (4) ease of application that saves time, money, and metal. See how this system can bring lasting beauty to your plant, machinery, equipment, tanks, fences, etc. Your Rust-Oleum Industrial Distributor, with your Rust-Oleum Factory Specialist, will be happy to survey your plant and provide complete recommendations. Prompt delivery is assured from Industrial Distributor stocks in all principal cities of the U.S., Canada, and many countries around the world.

Faced with coating problems like these? Heat resistance, water resistance, chemical resistance, floors, galvanized metal, coatings that will dry in less than thirty minutes? Rust-Oleum, in its various systems, can be your answer. Call your Rust-Oleum Industrial Distributor, or write for the facts.

Apply Rust-Oleum 769 Damp-Proof Red Primer directly over sound, rusted surfaces to STOP RUST and cut maintenance costs

Just scrape and wirebrush to remove rust scale and loose rust—then brush Rust-Oleum 769 Damp-Proof Red Primer right over the remaining rust. Its **specially-processed** fish oil vehicle penetrates rust to bare metal as proved in radioactive tracing studies. You save time and money, as costly surface preparations are usually reduced.

RUST-OLEUM®

See our catalog in Sweet's.

STOPS RUST!®

Distinctive as your own fingerprint.
There are imitations,
but only **one** Rust-Oleum.
Accept no substitute.

PROVED THROUGHOUT INDUSTRY FOR OVER THIRTY-FIVE YEARS

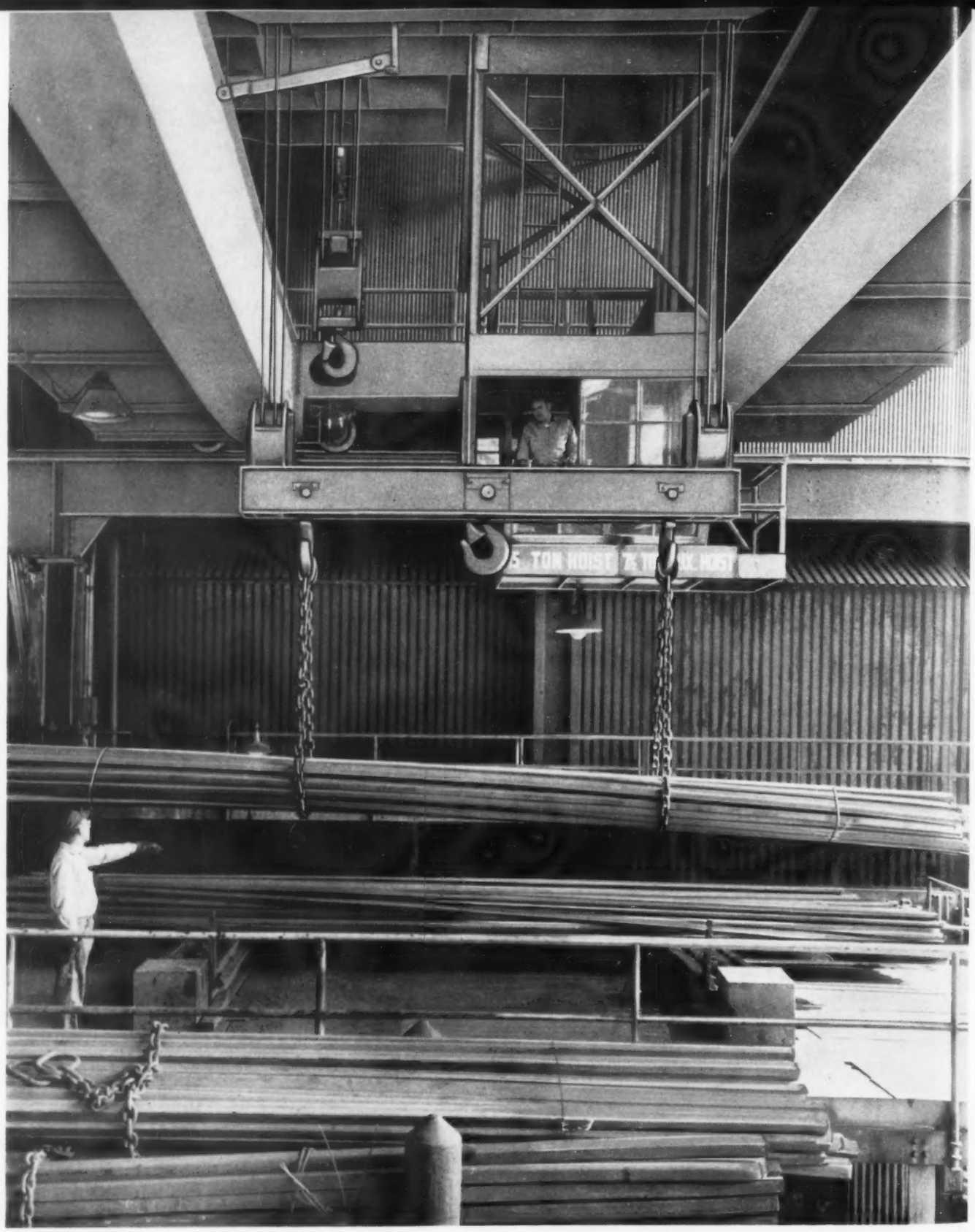
You take the brush! Try a free test sample!

ATTACH TO YOUR LETTERHEAD

RUST-OLEUM CORPORATION
2984 Oakton Street • Evanston, Illinois

At no cost or obligation, please send me:

- ☐ New full-color catalog on New Color Horizons System and specialized Rust-Oleum systems. Including color charts and applications.
- ☐ FREE TEST SAMPLE of Rust-Oleum 769 Damp-Proof Red Primer.
- ☐ Please have your representative contact us to discuss a plant survey.



CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 E. 289th ST.
WICKLIFFE,
OHIO

Crops and Shorts

△ Steelmen continue to wax optimistic over production for the year. Joseph L. Block, Chairman, Inland Steel Co., believes second-half ingot production will total 55,000,000 to 60,000,000 tons, and 100,000,000 to 105,000,000 tons for the year.

Mr. Block bases his optimism on the broadening recovery in all three major sections of the economy. "Government spending is obviously headed upward, business expenditures are expected to improve, and the consumer seems to be losing some of his recent reluctance to purchase durable goods. Most forecasters are now predicting that industrial production will be above previous record highs by the end of 1961. This should mean a significant increase in steel consumption and additions to steel inventories by our customers to support their rising sales and manufacturing activities."

△ A report published by Engineers Joint Council, Inc., "The Training, Placement and Utilization of Engineers and Technicians in the Soviet Union," discusses the recent achievements and future goals of the U.S.S.R. in the field of engineering and engineering education and manpower utilization. The report is based on a tour of the Soviet Union made last year by six representatives of United States engineers, and throughout there are indications of the impressions made upon the delegation by the determination and zeal with which the Russians approach technical education.

Soviet secondary education prepares highly qualified students for advanced schooling, and according to the report, the Soviet "freshman" is generally better prepared for an engineering education than his American counterpart. A high degree of practical industrial experience is integrated into the study program. The delegation was also impressed with the interest in evening and correspondence study by technically employed persons. Strong incentives are offered by government and industry for employees to improve their professional skills by part-time study.

The Russians place great emphasis on copying and adopting the best designs of Western Europe and the United States, but occasional improvements are made which, according to the report, would astonish the original designers.

△ According to one of our correspondents, it's a sure sign of old age when the gleam in your eyes is from the sun hitting your bifocals.

△ Naughty books aren't new. They've just moved to the living room table from under the mattress.

△ The ratio of coke use to iron will continue to decline, but the over-all use of coal in the steel industry should rise substantially during the 60's, according to Harold C. Lumb, Vice President, Director of Law and Corporate Relations, Republic Steel Corp., in an address before the National Coal Association. Despite the inroads made by gas and oil, Mr. Lumb feels that coke will remain the key blast furnace fuel, but accessibility and cost will be the determining factor in any choice.

He cited increased steel production, lower-cost coke ovens, upsurge in the use of hot metal for oxygen processes, and improved technology to keep coal competitive costwise as the factors which will contribute to the coal industry's improved position in steelmaking.

△ Key question which remains unanswered in the battle over proposed legislation covering outdoor advertising: If billboards are banned, where will the motorcycle cops hide?

△ Starting rates continue to creep up on salaries paid to more experienced engineers because recent graduates are worth as much or more than many older men, according to Dr. Thomas Stelson, head of the Civil Engineering Department of the Carnegie Institute of Technology.

He noted that there are many individual cases where engineers wind up unemployed, or working in subprofessional capacities because of obsolescence, and thinks the situation is getting worse. "The trend implies that a new engineering graduate is near the peak of value to his employer and society, and that several years of experience may only add slightly to his professional stature." An engineer who wants to increase his value at a reasonable rate, according to Dr. Stelson, must devote about one third of his productive hours to self-education and improvement.

Dr. Stelson recommends improvement in undergraduate training, increased emphasis on graduate education, better on-the-job training, study leaves, and exchange of ideas through professional societies.

△ The reason some ideas die quickly in some heads is because they can't stand solitary confinement.

△ The Value Line Investment Survey believes that United States iron ore is losing ground to the richer and less expensive ore that has been uncovered in Canada, South America and West Africa. As a result, more than one-third of the ore consumed in domestic steel mills in 1960 was accounted for by imports.

Only with the investment of substantial sums of capital in beneficiation plants on the U. S. ranges, the Survey points out, can domestic ore be made truly competitive with new foreign sources. In the face of more than ample high-grade ore supplies in other parts of the world, the required investment in domestic ore facilities can probably only be spurred by substantial tax concessions from both federal and state governments.

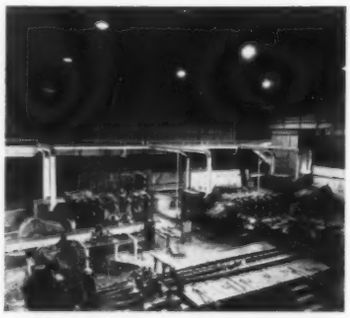
△ There must be something to reincarnation, judging by the way some people come back to life at quitting time.

Wheelabrator ultrafiltration provides air cleaner than you breathe

A demonstration of WHEELABRATOR'S

VITAL VALUES

Air that's pure—really pure—is vital to the operation of steel mill drive motors. And ultimate purity of the filtered air is one of the Vital Values you get with Wheelabrator Air Filters. At a prominent steel mill, installation of Wheelabrator Ultra-Filtration to provide clean air to three drive motors totaling 2,200 h.p. has virtually eliminated weekly motor maintenance attention, saving $3,120.00 in direct labor cost alone per year. Added to this saving, mill room down time costing $6,000.00 annually due to motor trouble has been avoided. Wheelabrator Ultra-Filtration provides the air purity required, at a cost far lower than many systems offering less efficiency. Get the whole story of these vital savings. Write today for information.



In this mill room, a Wheelabrator Ultra-Filtration® unit has eliminated the cost of 24 man-hours of maintenance labor a week in upkeep of 3 roughing mill drive motors.

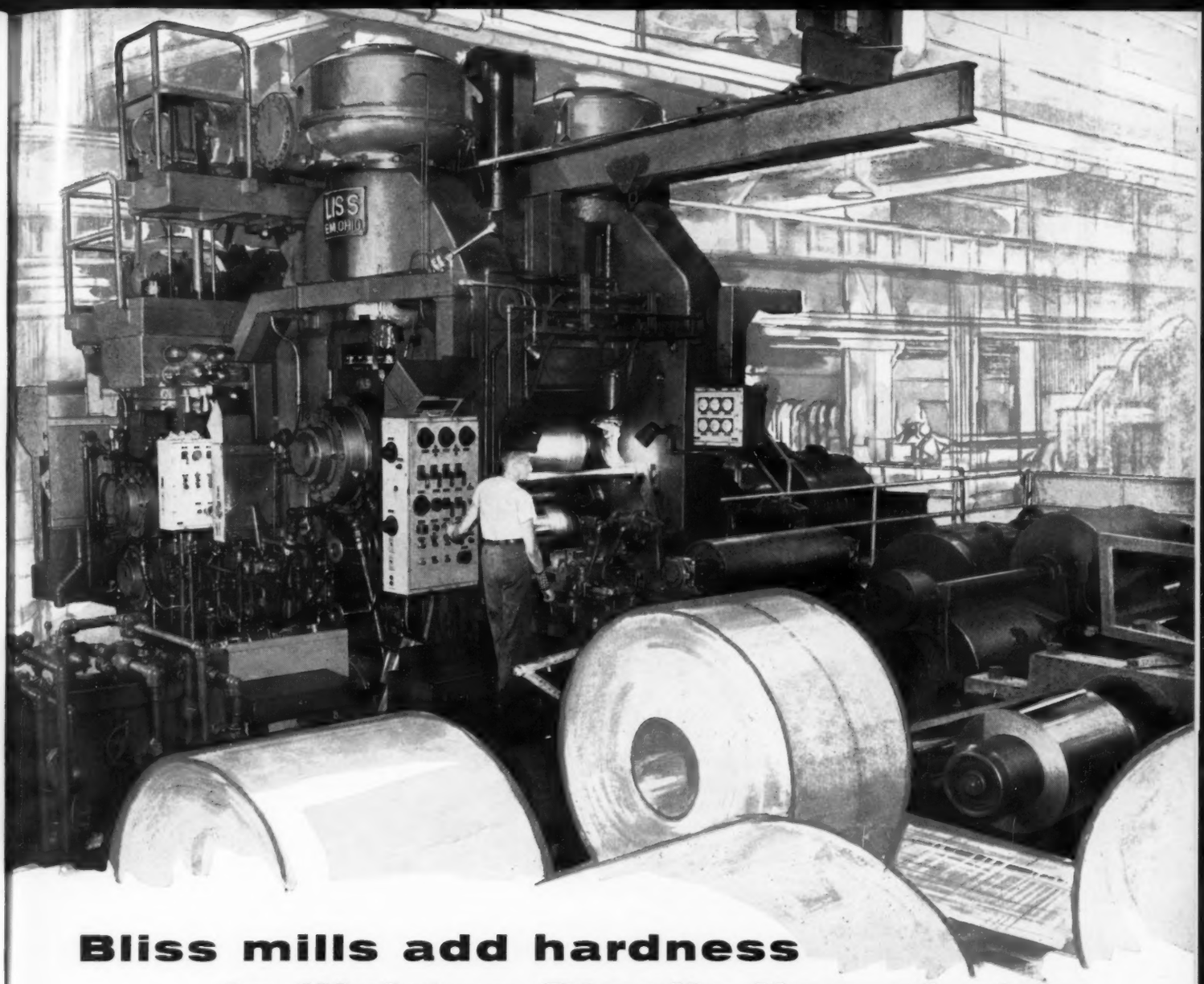
VITAL VALUES FOR INDUSTRY

WHEELABRATOR

AIR FILTRATION

WHEELABRATOR CORPORATION, 396 S. Byrkit St., Mishawaka, Indiana. In Canada, WHEELABRATOR CORPORATION OF CANADA, LTD. 1901 Birchmount Rd. P.O. Box 490, Scarborough, Ontario

A subsidiary of Bell Intercontinental Corp.



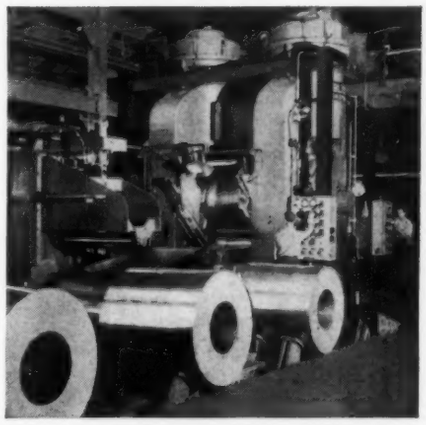
Bliss mills add hardness to Weirton Steel's line of strip

Weirton Steel Co., Division of National Steel Corp., the nation's largest independent producer of tin plate, uses a Bliss mill to achieve exacting temper and quality of its strip prior to plating. It is a four-high, two-high two stand tandem mill recently installed in its Weirton, W. Va., plant.

Through this unit Weirton has rolled a wide variety of steels in gages ranging from .00435 to .0147 inches and at an average maximum speed of 4,500 feet per minute. Well known products such as Weircote and Weirzin zinc coated steel are just two of Weirton's steel products to which this mill contributes.

A second Bliss mill tempers high-carbon, high-phosphorous, deep-drawing and galvanizing steels at the rate of 800 tons a day, while a new Bliss 48-inch slitting line is used to slit galvanized steel in gages from .0135 to .135 inches at speeds of 200 to 1,000 fpm. Both rolling mills are equipped with Amerigear-Bliss spindles.

These three installations provide one more example of the ready acceptance of the name of Bliss in the rolling mill industry—both here and abroad. To learn how Bliss equipment can help increase your rolling capacity, simply write for our new 84-page Rolling Mill Brochure, Catalog 40-B.



Four-high temper mill handles 30,000-lb. coils at speeds up to 3,500 fpm...has rolled 1,000 tons in a single day. Back-up rolls were supplied by Bliss' Mackintosh-Hemphill Division.

BLISS
SINCE 1837

Bliss is more than a name . . . it's a guarantee

E.W. BLISS COMPANY, Rolling Mill Division, Salem, Ohio

Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio

FOR QUALITY... PRODUCTIVITY ... PROFIT

METAL ROLLING
AUTOMATED BY GENERAL ELECTRIC

More steel producers to keep strip on-gage

turn to General Electric gage control automatically, increase yield per ton

To maintain strip gage . . . increasing output of saleable product . . . more and more steelmakers are using General Electric automatic gage controls. G-E gage control systems to be delivered in 1961 are equal in number to all automatic systems supplied since the first installation in 1955 . . . bringing to nearly 50 the number of General Electric designed systems in operation. Automatic gage control is another of many products and systems General Electric has pioneered in 75 years of developing and building equipment to help make metal rolling faster, more efficient, and more profitable.

Two automatic gage control systems . . . a cold-mill system first applied in 1955, and a hot-mill system successfully applied in 1958 . . . result in greater yield of usable strip per ton while reducing costly downtime resulting from less-efficient manual adjustment systems. Look at the benefits in these two key areas:

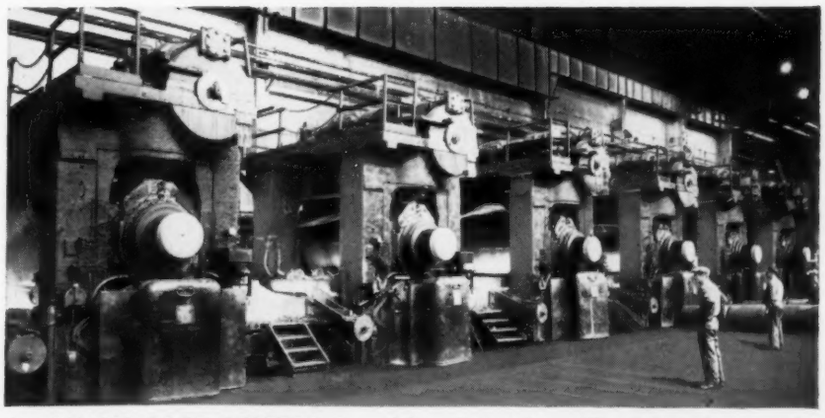
Higher quality strip—more uniform strip throughout because off-gage signal automatically activates corrective equipment . . . strip gets on-gage sooner, stays on-gage longer . . . more usable strip per ton.

Maintenance and downtime reduced—long-life, solid-state semi-conductors with no moving parts are used . . . "plug-in, plug-out" replacement of faulted parts permits full production during repair.

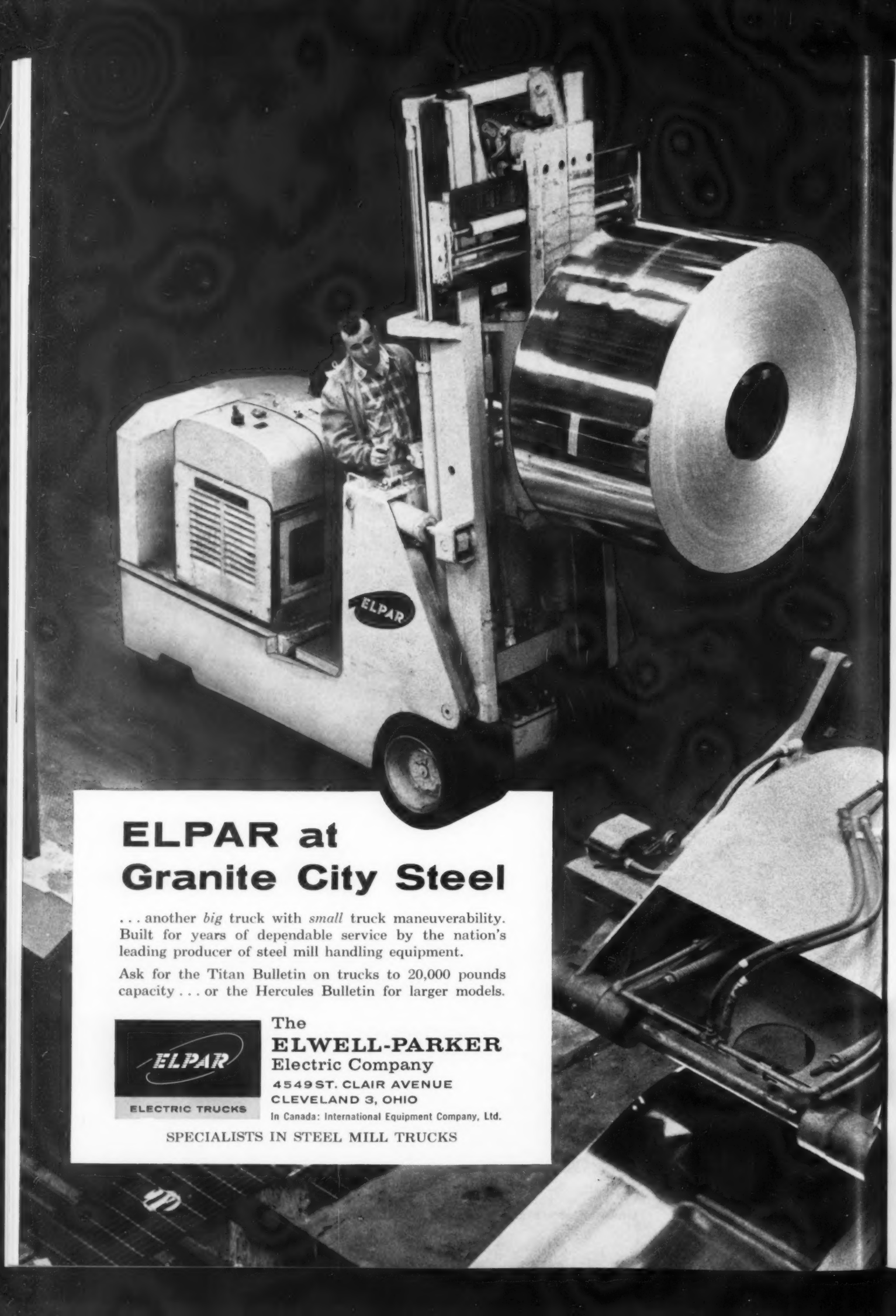
Let General Electric's experience in steel mill control, and leadership in automating all types of process control, help you in your modernization program or in your plans for new facilities. See your General Electric sales representative. For more details on gage control, write Sect. 785-14, General Electric Co., Schenectady, N. Y.
Industry Control Department, Salem, Virginia.

Progress Is Our Most Important Product

GENERAL ELECTRIC



AUTOMATIC GAGE CONTROL for either hot-strip mills (above) or cold-strip mills is just one of many automated systems designed and built by General Electric to help you meet increasing competition.



ELPAR at Granite City Steel

. . . another *big* truck with *small* truck maneuverability. Built for years of dependable service by the nation's leading producer of steel mill handling equipment.

Ask for the Titan Bulletin on trucks to 20,000 pounds capacity . . . or the Hercules Bulletin for larger models.

ELPAR
ELECTRIC TRUCKS

The
ELWELL-PARKER
Electric Company
4549 ST. CLAIR AVENUE
CLEVELAND 3, OHIO
In Canada: International Equipment Company, Ltd.

SPECIALISTS IN STEEL MILL TRUCKS

patent reviews

by MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period February 14, 1961 to March 21, 1961.

CONSTANT GAP CONTROL FOR SHEET SHEARING LINES

△ U. S. 2,971,414, issued Feb. 14, 1961 to Albert G. Owen and assigned to Blaw-Knox Co., relates to apparatus for shearing rapidly moving strip material such as steel or tin plate into sheets by means of a flying shear and handling the sheets after the shearing has taken place.

The object of the invention is the provision of an apparatus for automatically controlling the speed of the conveyor that receives sheets from a flying shear in a shearing line at such a value as to maintain the gaps between the sheets on the conveyor substantially constant.

The apparatus is shown schematically in Figure 1. The desired length of gap is automatically maintained by controlling the speed of the receiving conveyor 17 in accordance with a signal derived from the speed of the entering strip and a signal that is a function of the number of cuts per minute made by the flying shear. The speed of the motor 30 which drives the receiving conveyor 17 is controlled in accordance with the algebraic sum of signals derived from a d-c tachometer generator 45 driven by the rolls 14 at a speed proportional to the speed of the entering strip, a d-c tachometer generator 46 driven by the shear 15 so that the output of the tachometer generator 46 is a function of the number of cuts per min made by the shear, and a d-c tachometer generator 47 driven at a speed proportional to the speed of the receiving conveyor, which furnishes a feedback signal that is opposed to the signal derived from tachometer 45.

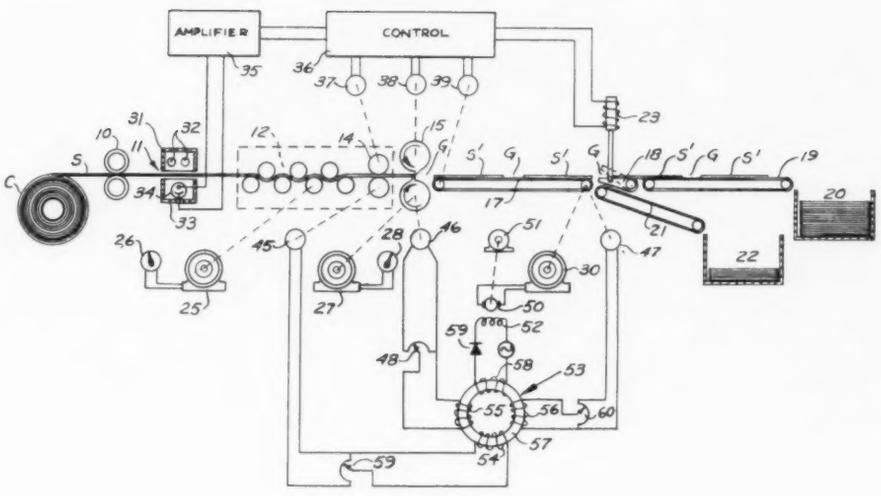


Figure 1

CLEANING AND RECOVERING SCRAP METAL FROM SLAG

△ U. S. 2,971,703, issued Feb. 14, 1961 to Frank E. Rath, relates to the selective recovery of materials from metal bearing refuse and debris, and particularly from slags which are produced by steel plants. It deals with the recovery of both magnetic and nonmagnetic metals and high iron content magnetic materials from open hearth flush or runoff slags, open hearth tap or finishing slags, electric furnace or other steel producing slags, as well as from soaking pit bottom materials, rolling mill debris, or mixtures of all of these materials.

The process is divided into three principal parts. The preprocessing part of the process provides a process burden consisting of slags, metals, etc., all of which has been broken down to minus 12 in grid or screen mesh size.

In the second part, the metal content of a size suitable for direct charging into open hearth and

electric furnaces is released, cleaned, and separated out with respect to the remainder of the burden. Simultaneously, the average piece size of the burden is reduced and smaller metal pieces and desirable magnetics are released from the slag and the other foreign material in which they were embedded. The cleaning and separating of the metal content of the burden is effected by a new type of apparatus, in the nature of rotary impact crushers, used with roller screens and electric vibrating screens for separating metal content down to 1-in. mesh size. The metals themselves, being malleable, are not broken up by the type of impacting-crushing action, while the other constituents of the process burden, including magnetic and nonmagnetic slags, are:

In the third and final part, the burden is separated into magnetic and nonmagnetic portions and the separate portions successively and progressively processed down to substantially its full extent for recovery of the value content of the burden.

Electrically vibrated screens are used to separate the magnetic materials into specific size classifications to enable the purification and refining procedures which follow. Roll crushers are used in releasing or breaking away and segregating-out the magnetic metal and desirable magnetic slag content in combination with magnetic selectors or separators.

Figure 2

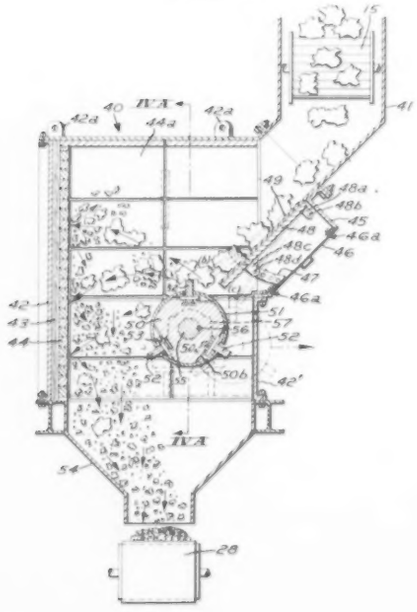


Figure 2 shows the rotary crusher or impactor used. Oversize slag material is shown entering the impactor and, after impacting, being discharged onto a belt conveyor. Energy of impact is transmitted to the material by the rotary wheel or impactor means 50. The peripheral surface of the impactor 50 is protected by an abrasion-resistant steel facing 51 of suitable thickness. Radially-positioned mounting slots 50a project outwardly toward the cylindrical surface or face of the impact rotor 50 and correspond in number and spacing to the desired spacing and number of impactor blades or elements 52, which are constructed of an alloy steel such as a molybdenum-silicon alloy.

DEVICE FOR FEEDING PARTICLES TO FLUIDIZED BEDS

△ U. S. 2,972,501, issued Feb. 21, 1961 to Jerome Feinman and assigned to United States Steel Corp., describes a device for feeding particles to fluidized beds.

Figure 3 shows a conventional closed vessel 10 which contains a horizontal perforated partition 12. A bed B of fluidized particles is supported on said partition. Fluidizing gas enters the bottom of the vessel, as indicated at 13, flows upwardly through the partition and bed, and discharges from the top of the vessel, as indicated at 14. Particles feed to bed B through a metering device 15 and a dip pipe 16. The dip pipe is located adjacent to the left side of the reactor and extends to a point near the bottom of bed B. Particles discharge from the top of the bed through a conventional overflow pipe 17. The overflow pipe is equipped with a valve 18.

The dip pipe 16 contains a number of openings 19 located within vessel 10 above the upper face of bed B. Fluidizing gas flows upwardly through the dip pipe and escapes through openings 19 back into the vessel. Thus the gas maintains particles within the pipe as a fluidized column B1, whereby bridges or plugs do not form, and the flow of particles into bed B is smooth and uninterrupted. To prevent particles from spilling out the openings 19, these openings must be located some distance above

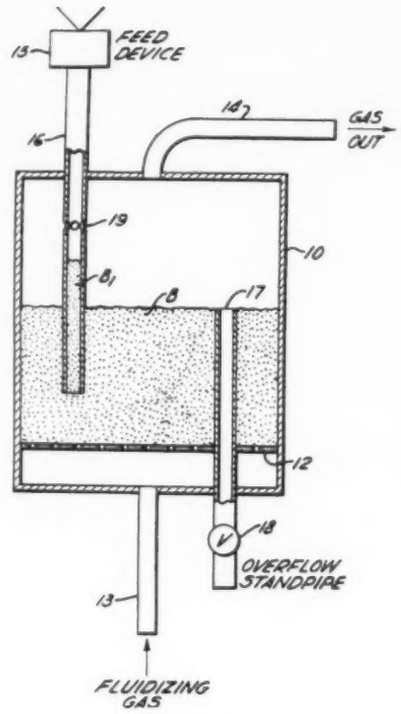


Figure 3

the height of the fluidized column B1.

AUTOMATIC STRIP THICKNESS CONTROL

△ U. S. 2,972,268, issued Feb. 21, 1961 to John W. Wallace, Robert E. Hull and Raymond W. Moore, and assigned to Westinghouse Electric Corp., provides automatic strip thickness control apparatus.

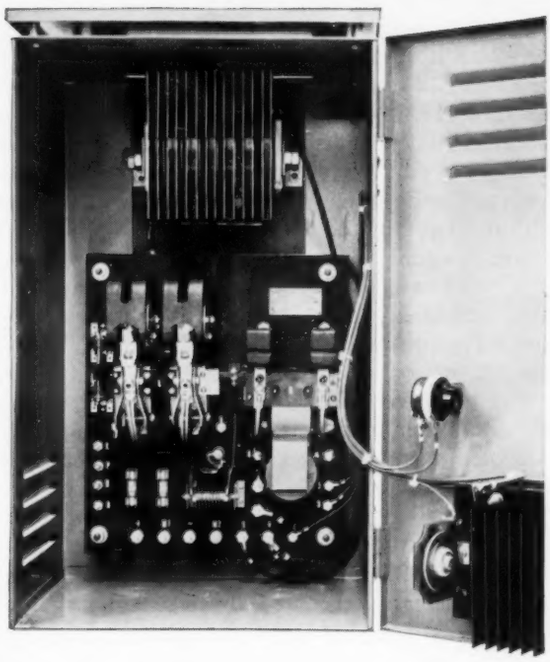
In Figure 4 there is shown control apparatus for a rolling mill including a mill stand 10 having an upper roller member 12 and a lower roller member 14 between which a strip of material 16 may be positioned, such that the spacing between the upper roller member 12 and the lower roller member 14 determines the thickness of the strip of material 16 after it has passed from the previous mill stand through the stand 10 to a successive stand or the delivery reel 20. A screw-down control device 22 is operated by a suitable motor 24 controlled by a screw-down control device 25 for determining the spacing between the upper roller member 12 and the lower roller member 14.

The operative speed of the stand 10 is determined by a motor 26 operated by a motor control device 28 which, in turn, is responsive to a control signal from a strain

EUCLID

LIFTING MAGNET CONTROLLERS PROVIDE 3-WAY RELEASE

Euclid Bulletin 4290 automatic discharge type magnet controller is the only one on the market today that will assure fast and clean release of full load, accurate release of partial load and precise control of dribbling. It can be used with all types and makes of lifting magnets in any industrial application.



EX-26

CUSTOM ENGINEERING IS OUR BUSINESS

We specialize in designing the control system best suited to your individual needs. Our services are yours for the asking. WHAT'S YOUR PROBLEM?

Ask for Bulletin 4290

The EUCLID Electric & Mfg. Co.
Dept. A • MADISON • OHIO

gage device 30 mounted on the mill stand 10 and responsive to the pressure between the upper roller member 12 and the lower roller member 14, as reflected by strain induced in the housing of the mill stand 10, and thereby the spacing between said roller members. The strain gage device 30 provides a control signal to a first amplifier device 32 which, in turn, provides this amplified control signal to a second amplifier device 34, and to an integration device 36 which, in turn, provides a control signal to the amplifier device 34. The resultant output signal from the amplifier device 34 is supplied to the motor control device 28 for controlling the operation of the mill motor 26 in accordance with a control signal received from the strain gage 30. If this resultant control signal has a value greater than a predetermined value, a control signal is supplied to the screw-down control device 25.

TREATMENT OF IRON ORES

△ U. S. 2,973,260, issued Feb. 28, 1961 to Yukio Nogiwa provides a method for heating, reducing and melting iron ores in a relatively simple apparatus under good conditions with an excellent thermal efficiency.

As shown in Figure 5, several furnaces of the cyclone type are employed as arranged in series. For instance, a part of those furnaces is used as reducing gas generating furnaces, while the others are respectively employed as a furnace for adjusting reducing gas temperature, a reduction furnace and a melting furnace or a furnace for performing simultaneously reduction and melting, whereby powdered raw iron ore is suspended in the reducing hot gas current by cyclonic action in the heat-reduction furnace as well as in the melting furnace, thus the raw iron ore powder is rapidly heated, reduced and melted.

The furnace I is a reducing gas generating furnace; the furnace II is a melting furnace; the furnace III is supplied with the source material for making reducing gas and constitutes a gas-regulating furnace and the temperature of the generated reducing gas can be so adjusted in the furnace that the reducing gas thus adjusted may be blown into a subsequent heat-reduction furnace IV so as to be able to prevent the reduced iron powder or iron ore powder in the heat-reduction furnace from cohering with each other and also from adhering to its furnace wall; the furnace IV is a heat-reduction furnace in which the reduction of preliminary reduced iron powder or iron ore powder as well as the heating of the preheated slag forming material, introduced from a pretreating furnace V are effected and the furnace V is a furnace for conducting preliminary reduction and heating, in which the preliminary heating of the powdered raw iron ore and slag forming material, such as limestone as well as the preliminary reduction

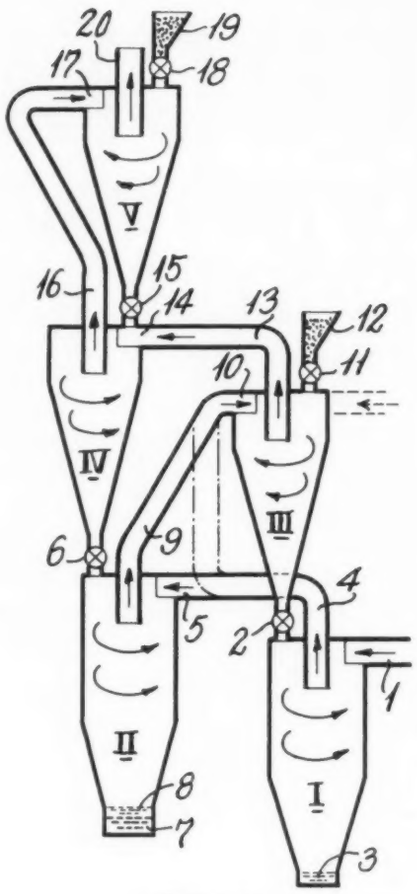


Figure 5

of the said iron ore powder can be effected.

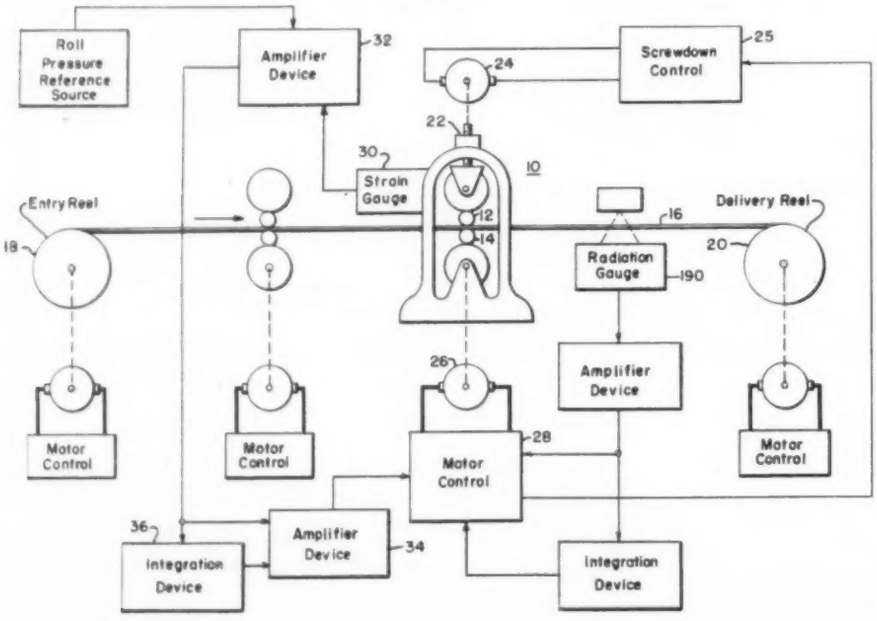
CONTINUOUS PREREFINING OF MOLTEN PIG IRON

△ U. S. 2,975,047, issued March 14, 1961 to Pierre Leroy and Roger Simon, assigned to Institut de Recherches de la Siderurgie, provides a process for the continuous prerefining of molten iron.

In Figure 6, there is shown a runner section 23 constituting the inlet means for a stream of molten pig iron to the treatment zone built according to the present invention. This treatment zone includes a cooling and mixing basin 22 which may be made of sheet metal lined with a suitable refractory material to withstand the heat of molten pig iron. Channel means constituted by runner section 1 are arranged adjacent to the cooling basin to receive a continuous flow of molten pig iron from it. The stream of pig iron is prerefined in runner section 1 and the prerefined metal leaves this section at discharge end 29.

The central area 24 of basin 22 is not insulated while the peripheral portions of the basin bottom are

Figure 4



Artist's rendering of a B-L-H Loewy water-hydraulic extrusion press

What you should know about B-L-H Loewy extrusion presses

This is not decision-clinching information. But it is, we think, enough to make you want to consult us if you are thinking of buying an extrusion press.

B-L-H designs and builds hydraulic presses to handle all extrudible metals and alloys. These machines permit a combination of the variable operating conditions of pressure, speed, temperature and billet size. They are, moreover, built for the utmost economy of man-hours, cycle time, horsepower, maintenance and floor space.

In B-L-H Loewy designs, automatic control has been developed to the highest degree of functional perfection. Extrusion speed adjustment, billet, dummy and cleanout disc handling, die change and rotation—all can be fully mechanized.

Rigid welded steel construction insures precision alignment and, where tubular products are concerned, highest concentricity. Advanced design of press components prevents warping at high operating temperatures. Auxiliary movements are provided with independent pressure supply.

For detailed information, write Dept. C-7.

BALDWIN · LIMA · HAMILTON

Industrial Equipment Division · Philadelphia 42, Pa.

Steel

AL

ARMCO

BETHLEHEM STEEL

FORD MOTOR CO.

INLAND

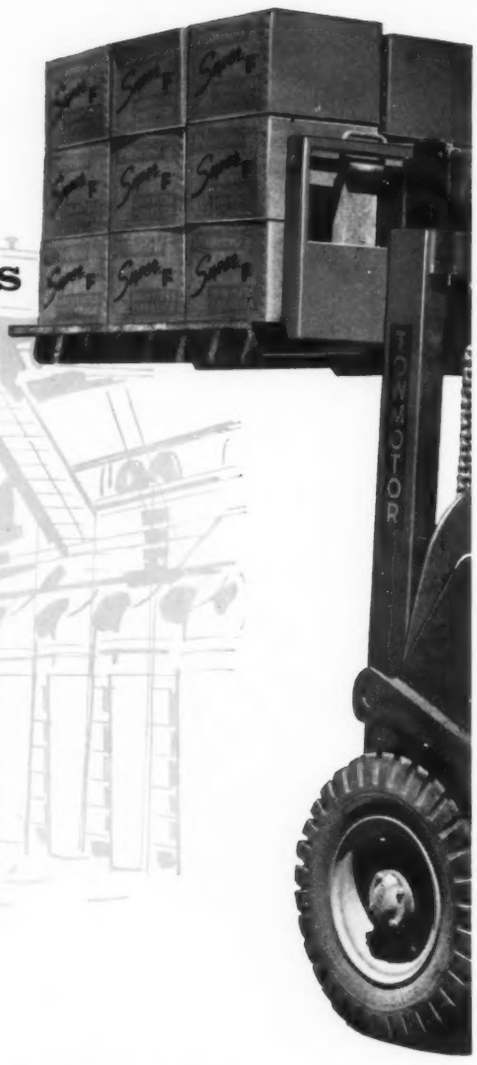
JESSOP

JL STEEL

TIMKEN

USS

More Plibrico Refractories on the way to these firms



. . . how about YOURS?

Today's producers of steel leave nothing to chance when they select a Plibrico product that's precisely matched to their service requirements.

Plibrico has a wide selection of plastics, castables, ramming and gunning mixes, each available in grades specifically formulated to give you just what you need . . . whether it's for severe, average, or fluctuating temperatures . . . mechanical or thermal shock . . . extreme abrasion or gaseous acid penetration . . . high insulating efficiency . . . load bearing strength, or any other need.

Pioneers in monolithic refractories, Plibrico also offers you the experience of their engineering department and trained installation crews to give you a completely reliable and integrated service.

SINCE 1914—PIONEERS IN REFRACTORY SPECIALTIES

REFRACTORIES INCINERATORS ENGINEERING CONSTRUCTION

Plibrico

PLIBRICO COMPANY

1804 North Kingsbury Street, Chicago 14, Illinois

Canadian Plant: New Toronto, Ontario

Sales and Service Throughout the World

1202

CATALOGS 68 & 71 cover plastics, ramming mixes and castables giving advantages and applications.

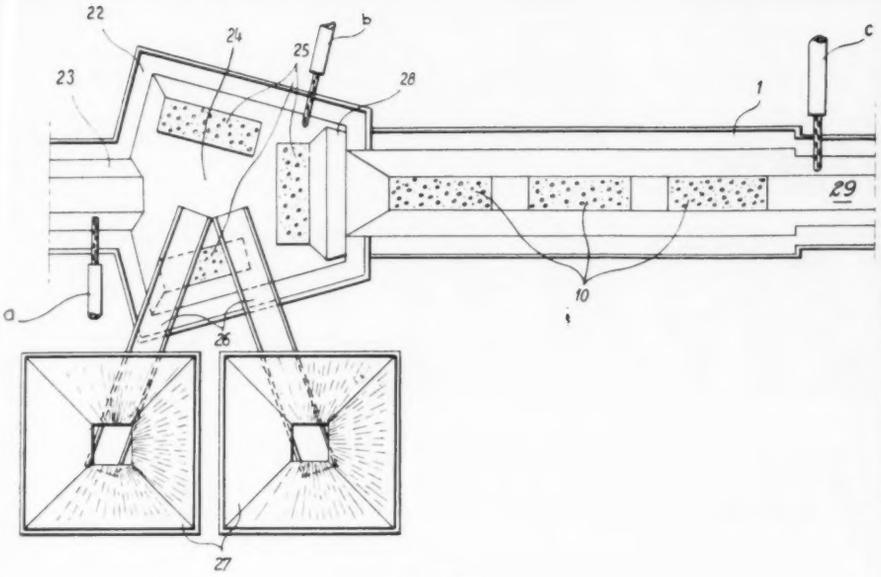


Figure 6

provided with porous gas feeding elements 25 of suitable refractory material. The feeding elements are connected to a supply of gas (not shown). Runners 26 constitute conduit means for supplying solid additives to the molten pig iron in basin 22, the runners leading from hoppers 27 containing a supply of suitable additives to the center area 24 of the basin. An adjustable gate 28 of refractory material is arranged between the cooling and mixing basin 22 and the prerefining runner section 1 to maintain the necessary level of pig iron in the basin for obtaining satisfactory stirring and mixing.

The solid additives, descending through runners 26 to the center of the basin into the stream of pig iron arriving from inlet 23, are stirred into the stream by the gas bubbles discharged through porous elements 25. The solid additives are prevented from sticking to the side walls of the basin by locating the gas feeding elements at the periphery of the basin. If the gas itself has a sufficient cooling effect to assure satisfactory temperature conditions for the oxidation, no solid cooling agents (which may also be oxidizing) need be added to the mass. However, an addition of a solid cooling agent, such as lime, is generally necessary to give the prerefining slag the optimum analysis. The amount of solid additions may be readily adjusted by modifying the outlet openings of hopper 27 to obtain the optimum temperature for the oxidizing operation.

From basin 22, the pig-iron stream flows over gate 28 into the prerefining zone 1 whence it is discharged at 29 with a desirably low level of reducing elements.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,972,393	2/21/61	Treatment of coke-oven gas.....	Allied Chemical Corp.
2,972,422	2/21/61	Apparatus for handling coke-oven doors.....	National Steel Corp.
2,973,307	2/28/61	Preparation of austenitic stainless steel for receiving a chromium plate.....	Lyon Inc.
2,973,564	3/7/61	Graphitization of cast iron.....	The International Nickel Co., Inc.
2,974,035	3/7/61	Nodular graphite steel.....	The Research Institute for Iron, Steel and Other Metals of the Tohoku University
2,974,090	3/7/61	High-velocity combustion-jet motivater coke-oven battery.....	Allied Chemical Corp.
2,974,397	3/14/61	Roll supporting means.....	The Osborn Mfg. Co.
2,975,106	3/14/61	Coke quenching stations.....	Koppers Co., Inc.
2,975,109	3/14/61	Drawing off gases from coking chambers.....	Koppers Co., Inc.
2,975,493	3/21/61	Continuous casting mold.....	The British Iron and Steel Research Assn.
2,975,663	3/21/61	Rolling mill.....	Franz G. Platzer
2,976,029	3/21/61	Sintering apparatus.....	Metallgesellschaft A.G.

USE THE COUPON
BELOW FOR MORE
INFORMATION
ON NEW
ECONOMICAL
PYROGARD C
FIRE-RESISTANT FLUID
See ad on following pages

Mobil

Mobil Oil Company, Room 2058A
A Division of Socony Mobil Oil Co., Inc.
150 East 42nd Street, New York 17, N.Y.

Gentlemen: I am interested in learning how new PYROGARD C fire-resistant fluid can aid my operation.

NAME
POSITION
COMPANY
ADDRESS
CITY
ZONE STATE

FOR IMPROVED PLANT SAFETY PLUS

NEW, ECONOMICAL

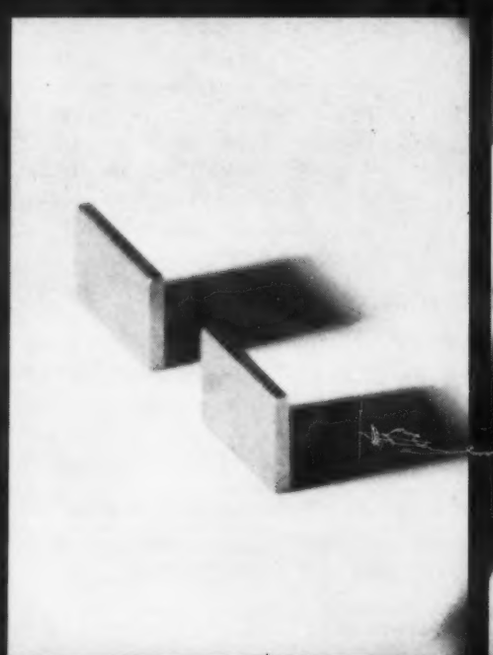
PYROGARD C

FIRE-RESISTANT FLUID

Mobil

HERE'S HOW PYROGARD C CAN HELP YOU!

Ignition resistance increases mill safety—PYROGARD C helps you protect your property and personnel against fire. Ignition resistance is demonstrated here. Hydraulic oil (left) bursts into flame immediately and PYROGARD C (right) resists combustion when poured onto steel plate heated to 1000F.



Good anti-wear properties assure long pump life—PYROGARD C fire-resistant fluid is designed for most pumps and pressures encountered in mill hydraulic equipment . . . gives excellent protection against pump wear for fluids of this type. Pump vane at left is new. Vane at right has 1000 hours of service with PYROGARD C at 160F and 1000 PSI. Wear is almost undetectable.

Compatibility with seals, metals eases fluid installation—PYROGARD C fire-resistant fluid is easily installed because it has no adverse effect on most packings, seals, or hoses, and is non-corrosive to metals normally found in mill hydraulic systems. Containing effective rust inhibitors, PYROGARD C fire-resistant fluid gives excellent protection against rusting wherever it contacts metal.

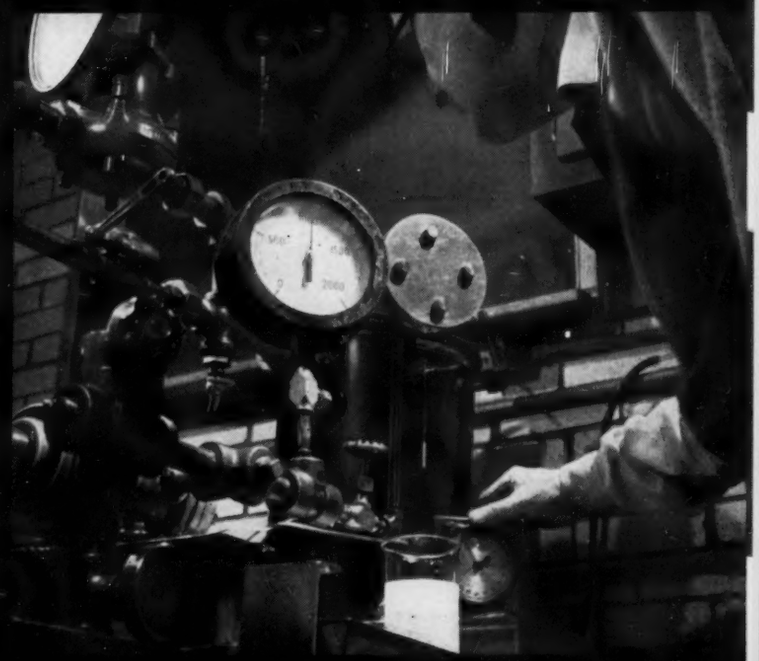
POSITIVE HYDRAULIC RESPONSE...

Now, the makers of world-famous Mobil petroleum hydraulic oils bring you PYROGARD C, a new fire-resistant fluid that offers positive hydraulic response plus improved plant safety . . . at low cost.

PYROGARD C fire-resistant fluid is a water-in-oil emulsion containing special chemical addition agents. It's been thoroughly field tested in actual service . . . will give excellent performance under conditions such as those encountered in press welders, furnace-door openers, ladle-tilting mechanisms, scrap balers, and die-casting machines.

The major benefits provided by PYROGARD C fire-resistant fluid are detailed below. In addition you receive the help of experienced Mobil Engineers in applying it to your equipment. Their specialized know-how in the installation and maintenance of fire-resistant fluids will make the procedure sure and simple. Examine the benefits of PYROGARD C fire-resistant fluid —then contact your nearest Mobil Representative.

Long-term stability in storage and use assures uninterrupted production—PYROGARD C fire-resistant fluid is highly stable even at higher-than-normal temperatures—resists breakdown, foaming and water separation—keeps pump parts and screens free of deposits. And with PYROGARD C, water evaporation is retarded by a thin oil skin that forms when the emulsion is at rest, yet readily remixes when fluid is agitated (shown above).



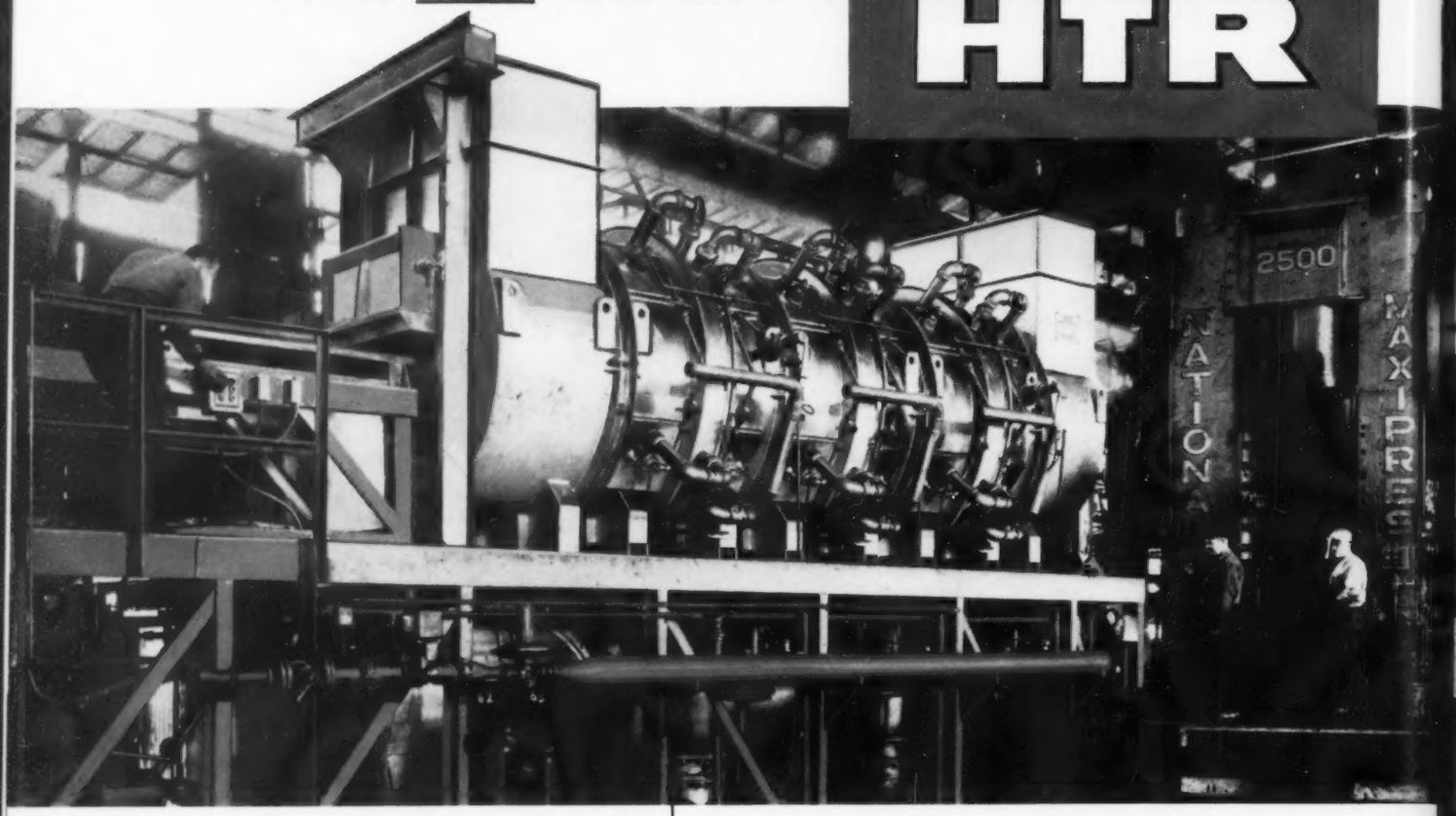
Unusual flow properties assure positive hydraulic response, yet reduce leakage—PYROGARD C fire-resistant fluid has unusual viscosity characteristics . . . resists leakage at static joints, yet gives rapid flow and response elsewhere in the system. In apparatus above, a specially designed "leak chamber," introduced into hydraulic system, shows the PYROGARD C leaks less than ordinary hydraulic oil.

MOBIL OIL COMPANY, 150 East 42nd Street, New York 17, N. Y.

HIGH-SPEED HEATING

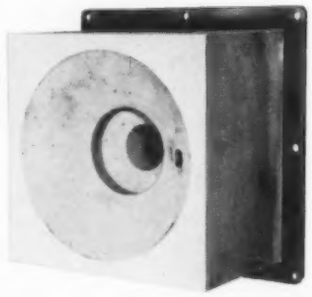
at its BEST with the . . .

BLOOM HTR



Courtesy of Gas Machinery Co.

No metallic parts exposed to high temperature.



Contoured port block gives high temperature radiating surface with no forward flame velocity.

Bloom HTR Burners were selected by the furnace builder to fire this high speed pusher type forge furnace. High heat release without flame impingement on the product and adaptability to furnace shape made the HTR Burner ideal for the job. Here are the results:

OPERATION

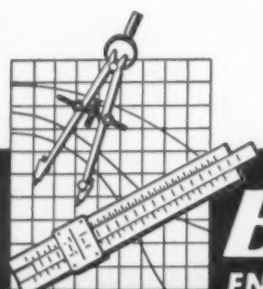
Material	4" cubes
Production rate	8000 lbs. per hour
Heating time	8 minutes—2 minutes per inch
Furnace temperature	2650° F
Scale condition	so light that no special scale removal equipment is needed.

MAINTENANCE

No furnace repairs	in first year
No burner or port block maintenance	of operation.

Other successful HTR Burner applications include:

- Tube Upsetting
- Continuous Strip Pre-Heating, Annealing, Coating, and Drying
- Batch type Forging
- Aluminum Chip Melting
- Glass Melting



BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

ENGINEERING EXPERIENCE EQUIPMENT

United Rolls . . . Ask any steelman and he'll tell you those words are almost as common to him as gauge and reduction. You'll get a similar response from the men who roll paper and rubber.

Service-proved United rolls have been on the job for more than 50 years—longer than the age of many of the men who rely upon them today for precise trouble-free rolling.

Behind each United roll application stands United's service engineers, metallurgists and roll makers. They have a wealth of experience, knowledge and skill. That's why United rolls set the quality standards for the industry.

1901 UNITED 1961

Progress...Leadership United for Sixty Years

Plants at Pittsburgh, Vandergrift, Youngstown, Canton, Wilmington

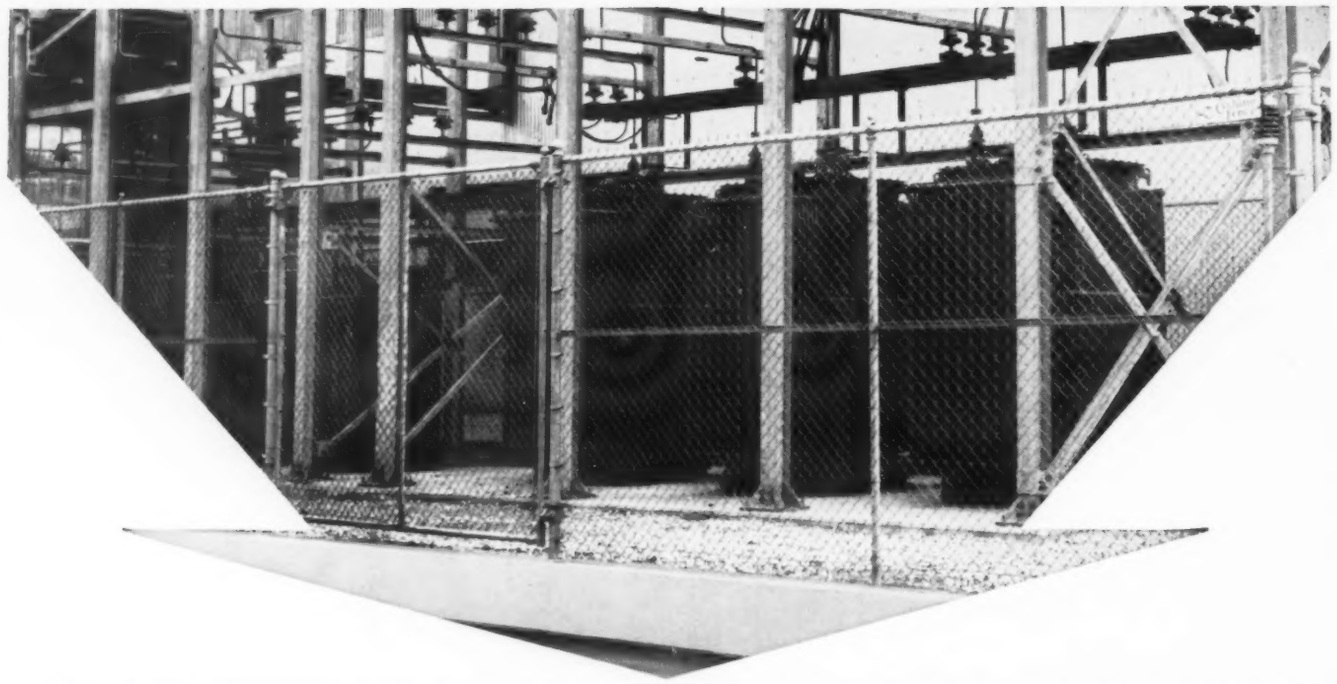
SUBSIDIARIES: Adamson United Company, Akron, Ohio
Stedman Foundry and Machine Co., Inc., Aurora, Indiana.

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.

UNITED

ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH 22, PENNSYLVANIA



SIX WAGNER® TRANSFORMERS PROVIDE THE POWER

Here are six Wagner® transformers with a full-time job: providing all the power needed by a new electroplating line that produces tin plate for Granite City Steel Company.

Three of the six supply power to motor-generator sets which convert to DC for variable speed drives, and to plating generation equipment and other major equipment drives. They are all 1667 kva, single phase, 60 cycles, 7200/12470Y to 2400/4160Y volts transformers.

The second set of three transformers are all 500 kva, single phase, 60 cycles, 7200/12470Y to 240 x 480 volts. They supply power for auxiliary pumps, etc.

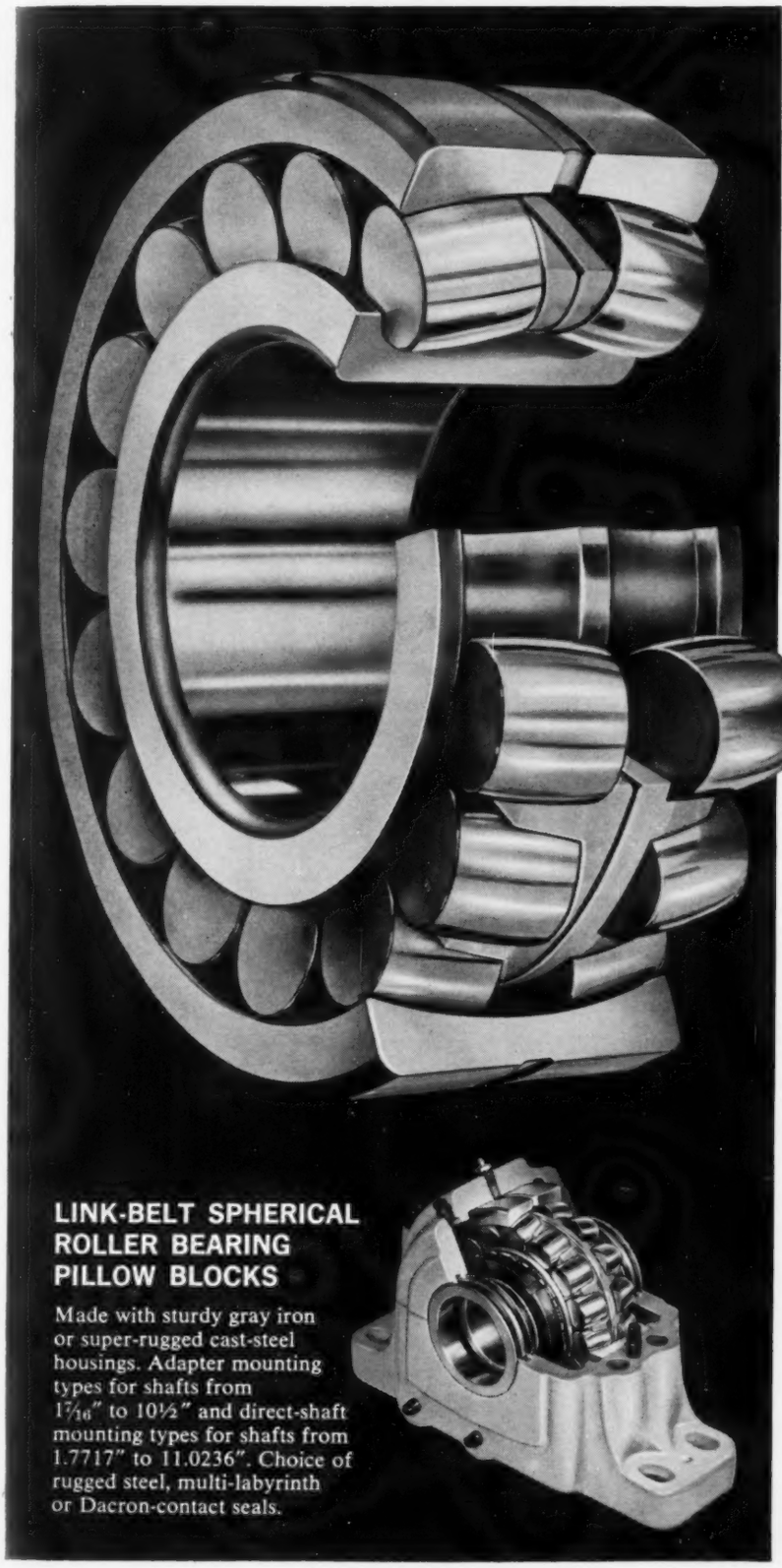
All six are of the latest design . . . have wound cores of cold-rolled oriented grain steel. Their performance stability is outstanding. They're built to be trouble-free . . . built to provide all the power the plating line needs. Wagner transformers are designed to provide all the power you need, too. Your Wagner Sales Engineer can show you how. Call him. Soon.

Wagner Electric Corporation
6483 PLYMOUTH AVENUE, ST. LOUIS 33, MO., U.S.A.

FOR GRANITE CITY STEEL'S NEW TIN PLATING LINE

LINK-BELT SPHERICAL ROLLER BEARINGS:

measure these design values in terms of your applications



LINK-BELT SPHERICAL ROLLER BEARING PILLOW BLOCKS

Made with sturdy gray iron or super-rugged cast-steel housings. Adapter mounting types for shafts from 1 7/16" to 10½" and direct-shaft mounting types for shafts from 1.7717" to 11.0236". Choice of rugged steel, multi-labyrinth or Dacron-contact seals.

GREATER CAPACITY!

The reason? *More rollers, larger rollers!* Bearing capacity depends primarily on effective roller Length, roller Diameter and Number of rollers (L x D x N). And Link-Belt offers the *largest effective roller complement* for all sizes of spherical roller bearings . . . rated according to accepted formulas of the Anti-Friction Bearing Manufacturers Association. This increase in LDN values provides extremely high capacity . . . and in users' evaluation, it adds up to far longer bearing life.

GREATER DURABILITY!

With balanced proportion design, Link-Belt spherical roller bearings possess durability characteristics that exceed the bearing industry's exacting requirements. Optimum balance of rollers, inner and outer rings must be obtained for increased bearing capacity . . . yet overall bearing dimensions must conform to an established international standard boundary plan.

Wrap-around, completely contoured retainers also contribute to durability through positive roller guidance and spacing. Precision-machined of centrifugally cast bronze, these husky retainers are far stronger than stampings or sand castings.

GREATER PRECISION!

Link-Belt spherical roller bearings are made in the world's most modern bearing plant . . . with the most-advanced tools and techniques known to industry. A rigid quality control program leaves *nothing* to chance. Each Link-Belt bearing is subjected to *758 actual inspections*. Microsmoothness and precision are continuously scrutinized by automatic machines. Result: these bearings have been specified by leading manufacturers of cranes, shovels, graders, vibrating screens, and steel mill, paper mill and foundry equipment . . . and for high-precision applications such as embossing rolls, printing presses and torque converters.

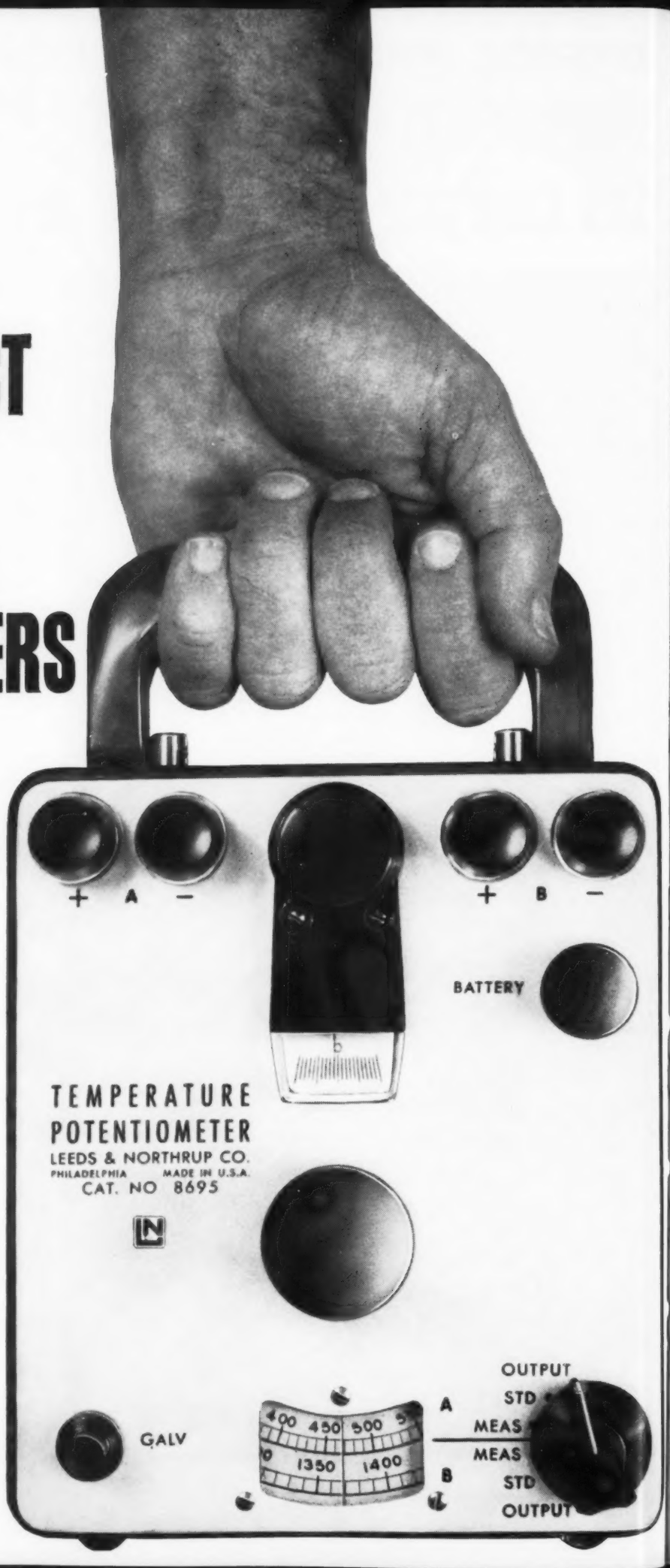
SEE BOOK 2760 for further precision, durability and high-capacity features. Contact your nearest Link-Belt office or authorized stock-carrying distributor. Look under BEARINGS in the Yellow Pages of your phone book.

LINK-BELT

SELF-ALIGNING BALL AND ROLLER BEARINGS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs; Switzerland, Geneva. Representatives Throughout the World. 15,691

NEW, COMPACT LOW COST L&N PORTABLE POTENTIOMETERS



If you check thermocouples, recorders or controllers in plant or lab and are tired of lugging around an oversize instrument just to get the precision you need, you'll welcome one of L&N's three new portable—*really* portable—potentiometers. All the essentials—galvanometer, battery, standard cell—are compactly housed in a 7″ x 6″ x 5″ case . . . and weigh only 4½ pounds. An 8694 Single-Range and an 8695 Double-Range Potentiometer read directly in degrees in any of 15 temperature ranges. An 8696 Potentiometer reads directly in millivolts on two ranges, 0 to 22 and 20 to 64 . . . has a manual reference junction compensation dial, and can be used as a source of calibrated voltage for checking other potentiometer-type instruments.

Get the full story on these new compact instruments—*and* their compact price (starting at $200.00). Just phone your nearest L&N Office, or write for Data Sheet E-33(5) from Leeds & Northrup Company, 4942 Stenton Ave., Philadelphia 44, Pa.

LEEDS & NORTHRUP

Pioneers in Precision

Roll Turning Lathes

FOR YOUR HEAVIEST METAL REMOVING NEEDS

Waldrich, Siegen, heavy roll lathe with 63" swing and 250 H.P. for highest metal removal capacity, working continuously for five years with outstanding results at The Ohio Steel Foundry Co., Lima, Ohio.

AMERICAN WALDRICH MFG. CORP.

1232 Penn Avenue, Pittsburgh 22, Pa. • H. A. WALDRICH G.M.B.H. SIEGEN, GERMANY

Meltth

lt the Cost of Making Steel

with NATIONAL CARBON'S "Four-Point Program"

Steel men know: The heart of the electric furnace is the electrode. Upon it depends so much of the success of furnace operations. But an electrode's performance is based on more than its component materials alone. Electrodes must be *engineered* to meet particular and demanding production conditions . . . and backed up by the supplier's reputation, service and facilities. Let NATIONAL CARBON help you reduce production costs through its "Four-Point Program."

Point 1

75 years of research and production experience in carbon products have built maximum life into "National" electrodes . . . providing more tons of steel per pound of electrode . . . saving the industry millions of dollars in materials and down-time.

Point 2

An industry-wide training program covering electrodes and electric furnace practices . . . designed to provide highest product performance through better utilization of power . . . to reduce refractory maintenance.

Point 3

Advanced electrode packaging and special-device gondolas speed shipments when and where needed . . . to save inventory and storage space . . . to keep investment at the most economical level. National Carbon's pool-car program provides these advantages for customers remote from its plants.

Point 4

Unsurpassed raw material supplies and technical skills at strategically located plants minimize electrode costs.

"National" and "Union Carbide" are registered trade-marks for products of

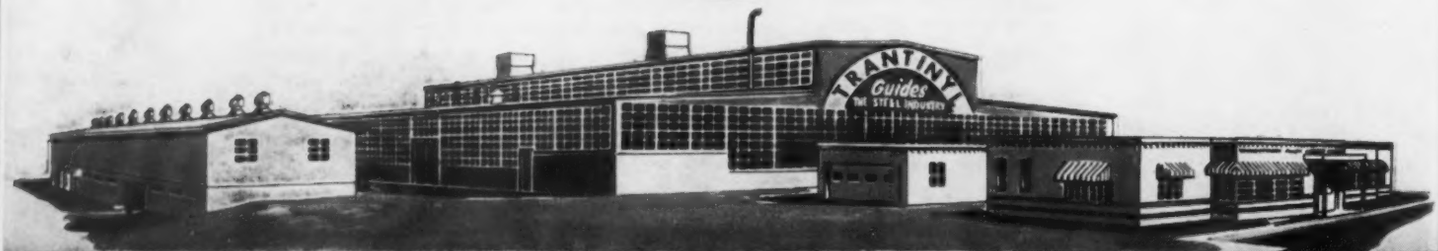
NATIONAL CARBON COMPANY

Division of Union Carbide Corporation, 270 Park Ave., New York 17, N.Y.

UNION CARBIDE

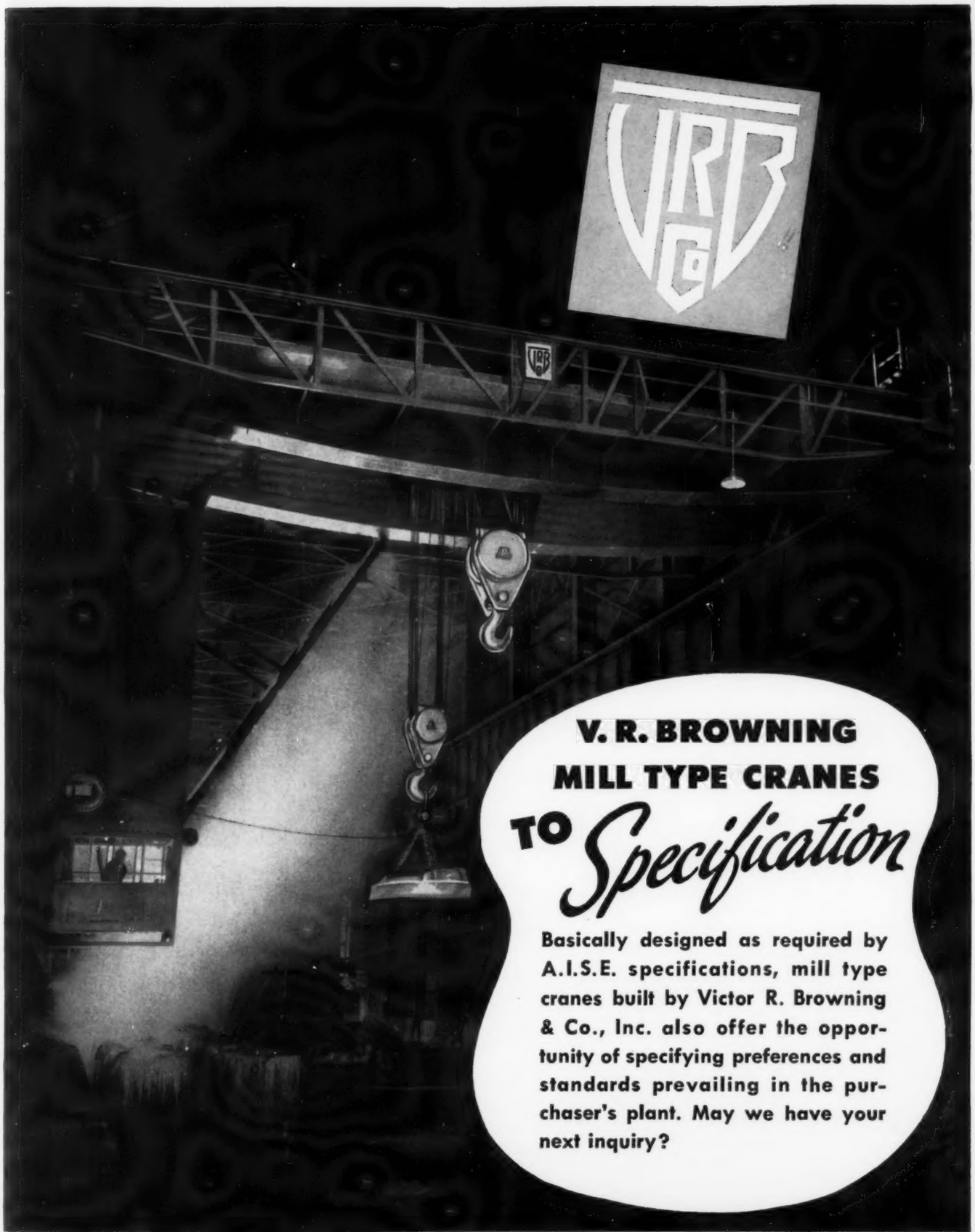
TRANTINYL

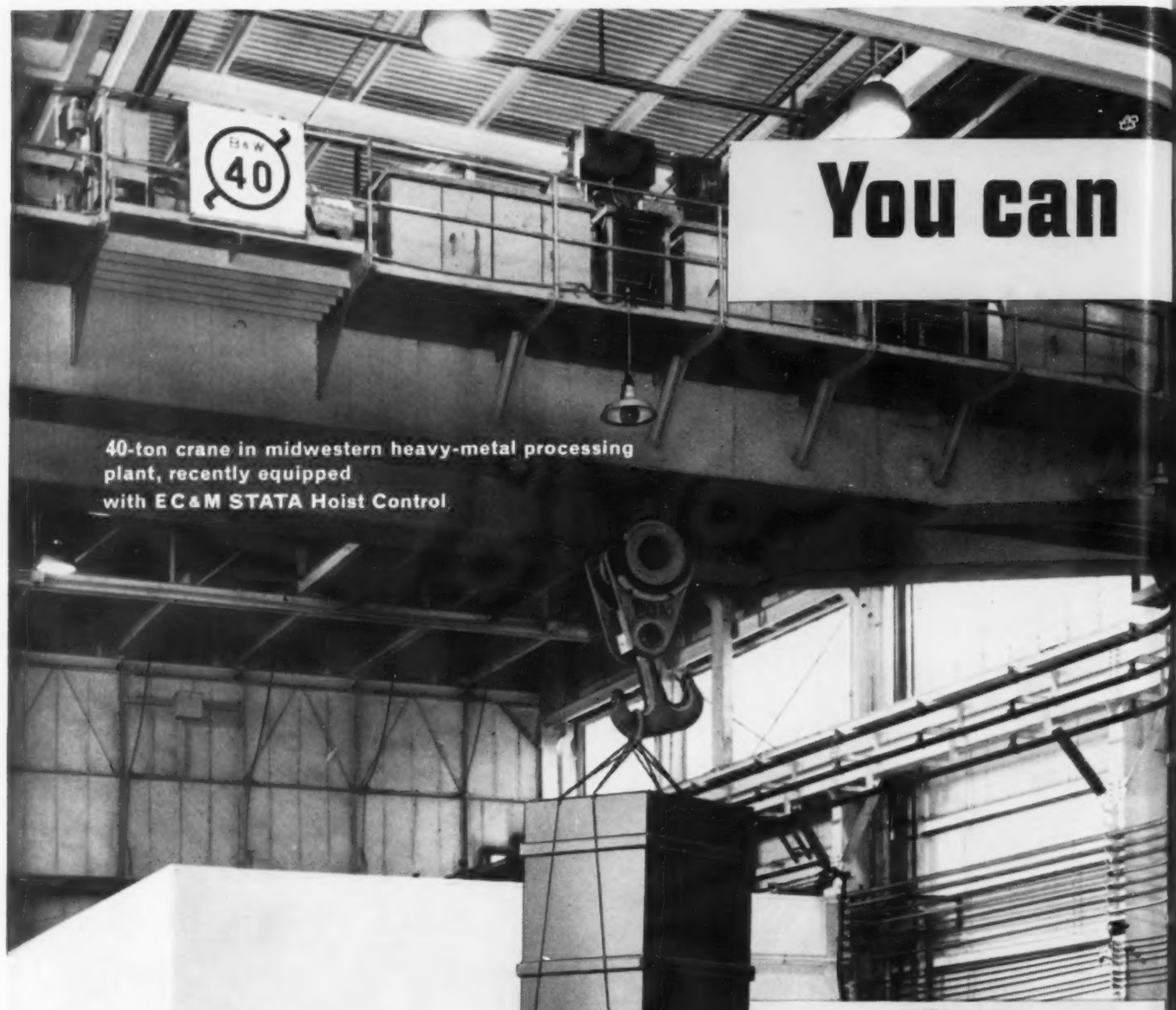
guides the steel industry



YOUNGSTOWN ALLOY CASTING CORP., • YOUNGSTOWN, O.

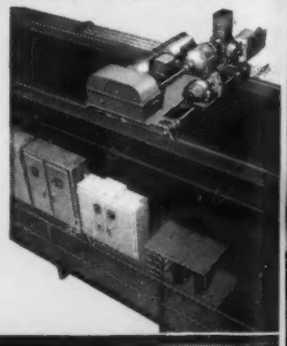
ROLLING MILLS: bar, hoop, strip, shape mill guides, and rollers. SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc. ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS


V. R. BROWNING
MILL TYPE CRANES
TO Specification
Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?
VICTOR R. BROWNING & COMPANY, Inc.
BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

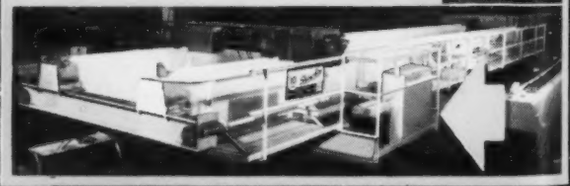


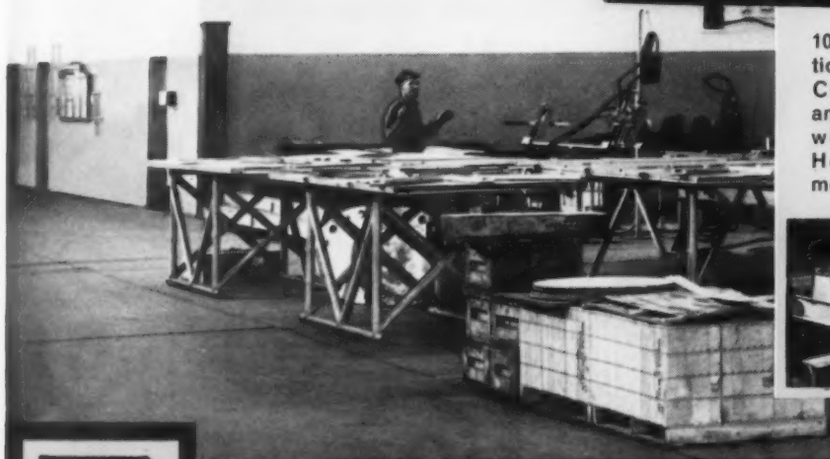
You can

40-ton crane in midwestern heavy-metal processing plant, recently equipped with EC&M STATA Hoist Control



10-ton cranes on erection floors of Whiting Corporation *(right)* and Shaw-Box *(below)* with EC&M STATA Hoist Controllers, mounted and wired





SQUARE D COMPANY

EC&M DIVISION • CLEVELAND 28, OHIO

spot 40 TONS—

—OR CRACK A WALNUT—WITH

EC&M STATA CONTROL

Now it can be done with precision by AC! EC&M STATA Hoist Control gives the finest electrically controlled speed regulation ever attained. Regardless of crane load, the operator can release the brake and hold any load stationary—a big advantage when landing loads, hooking-on, or unhooking. Also, the operator has infinite operating speeds between standstill and full load motor speed for both hoisting and lowering. The EC&M STATA Hoist Control provides these important benefits:

Fast response lets an operator change directions quickly, permits the hook to respond rapidly to master switch movements

No mechanical or electrical load brakes to mount or maintain

Fewer trolley (collector) bars than with any other stepless system

Fail-safe feedback circuitry removes power and sets brake if an open circuit occurs

Overhoisting protection with standard power-type (Youngstown) limit stop—no additional equipment to lower down after limit switch trips

Simplified maintenance—the static components, enclosed in sub-assemblies, are more reliable, more easily understood and provide convenient inspection or test points

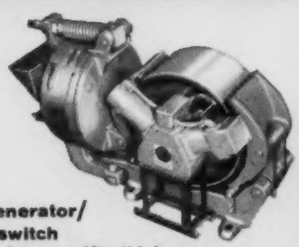
Float control, actuated by a push button in the master switch handle, permits standstill with the brake released; also provides creeping speeds, up or down

Front-connected control panels facilitate mounting, permit rapid testing or inspection. Full motor protection built into each panel

When buying cranes or revamping existing installations, investigate EC&M STATA Control

Write **FOR COMPLETE FACTS** • *Ask for Bulletin 6401—Square D Company, EC&M Division, 4500 Lee Road, Cleveland 28, Ohio*

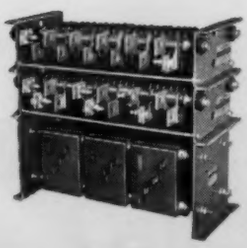
Compact, Coordinated Units for Easy Mounting on Crane Trolleys



Tach-generator/ Speed-switch unitized for easy (flexible) connection to wheel of EC&M WB hoist brake

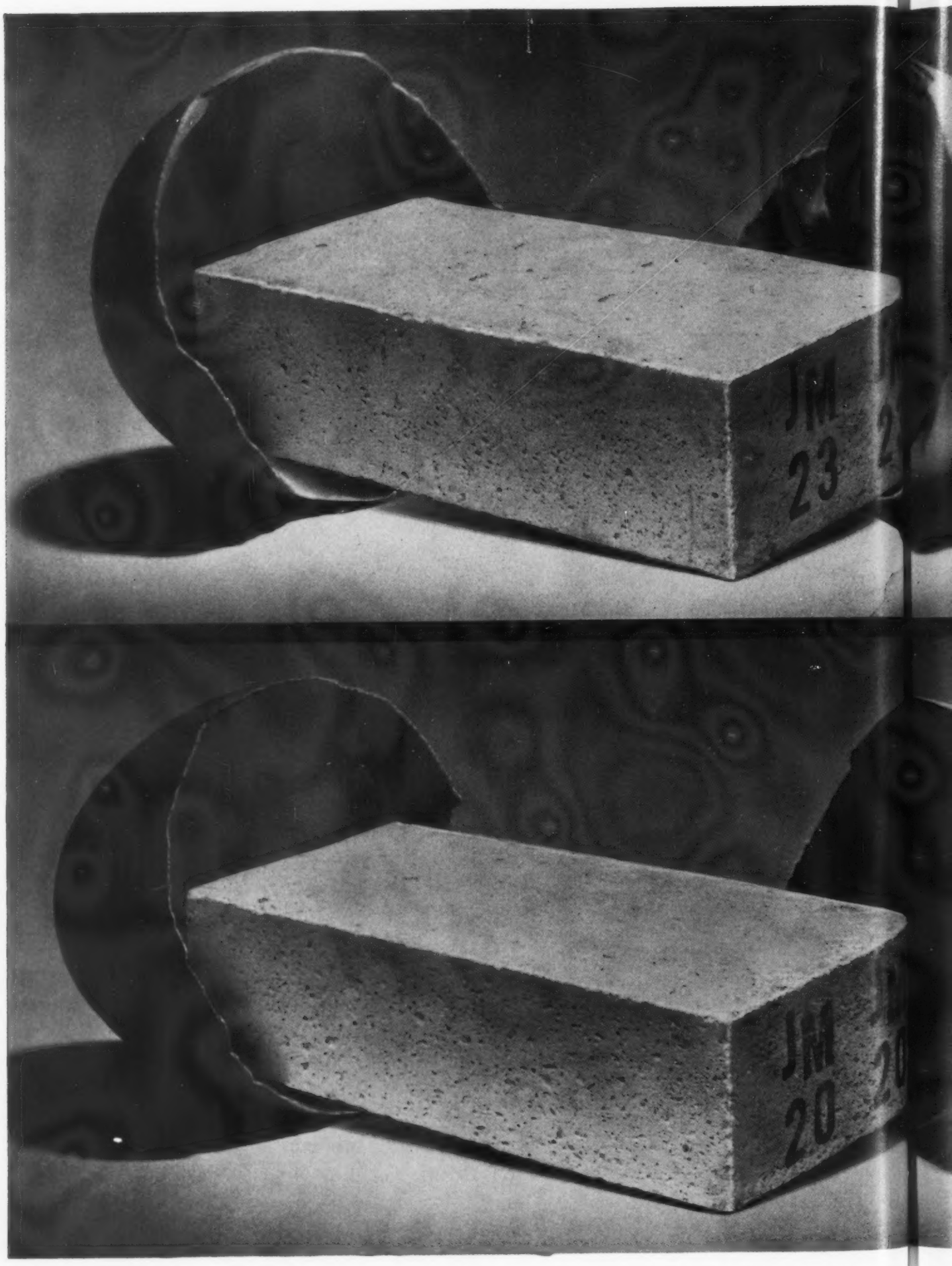
Power-type (EC&M Youngstown) Safety Limit Stop operates in normal manner to prevent overhoisting. Disconnects power, sets brake—resets automatically when master switch is moved to lower

Resistor-reactor assembly connects to motor slip rings... its fixed values eliminate secondary trolley collectors



wherever electricity is distributed and controlled

5350


JM
23
JM
20

Just out!
TWO new, high-purity J-M insulating fire brick for use in prepared atmospheres!

Now—just "hatched" by Johns-Manville's Research, Engineering and Production staff—two new, high-purity insulating fire brick: JM-23 designed for service to 2300F and JM-20 for use to 2000F. Both brick are for direct exposure or back-up insulating and are specifically designed to resist such gases as CO, H_2 and CH_4. These brick have the optimum balance of chemical and physical properties for effective heat-control service in prepared atmospheres.

New JM-23 and JM-20 Insulating Fire Brick Provide Outstanding Benefits

- **HIGH PURITY**—The new brick are made from carefully selected materials which have an extremely low iron oxide content.
- **LIGHT WEIGHT**—The new JM-23 weighs substantially less—about ⅓ less—than insulating fire brick previously available in its temperature range. The new JM-20 also is significantly lighter than the brick formerly available in the 2000F range.
- **HIGH STRENGTH**—Both brick have high cold crushing and hot-load strength.
- **HIGH INSULATING VALUE**—Both brick have an extremely low thermal conductivity.
- **SHAPES FROM SLABS READILY AVAILABLE**—Unique production methods perfected by J-M make it possible to cut accurate special shapes from slabs. The slabs are molded, fired rapidly through tunnel kilns and then cut into straights, arches, keys, wedges and a variety of other standard and special shapes.

For Complete Technical Data, Please Fill Out and Return the Coupon Below.

Johns-Manville, Box 14, New York 16, N. Y.
Please send me data on ☐ JM-23 IFB ☐ JM-20 IFB

NAME_____

FIRM_____

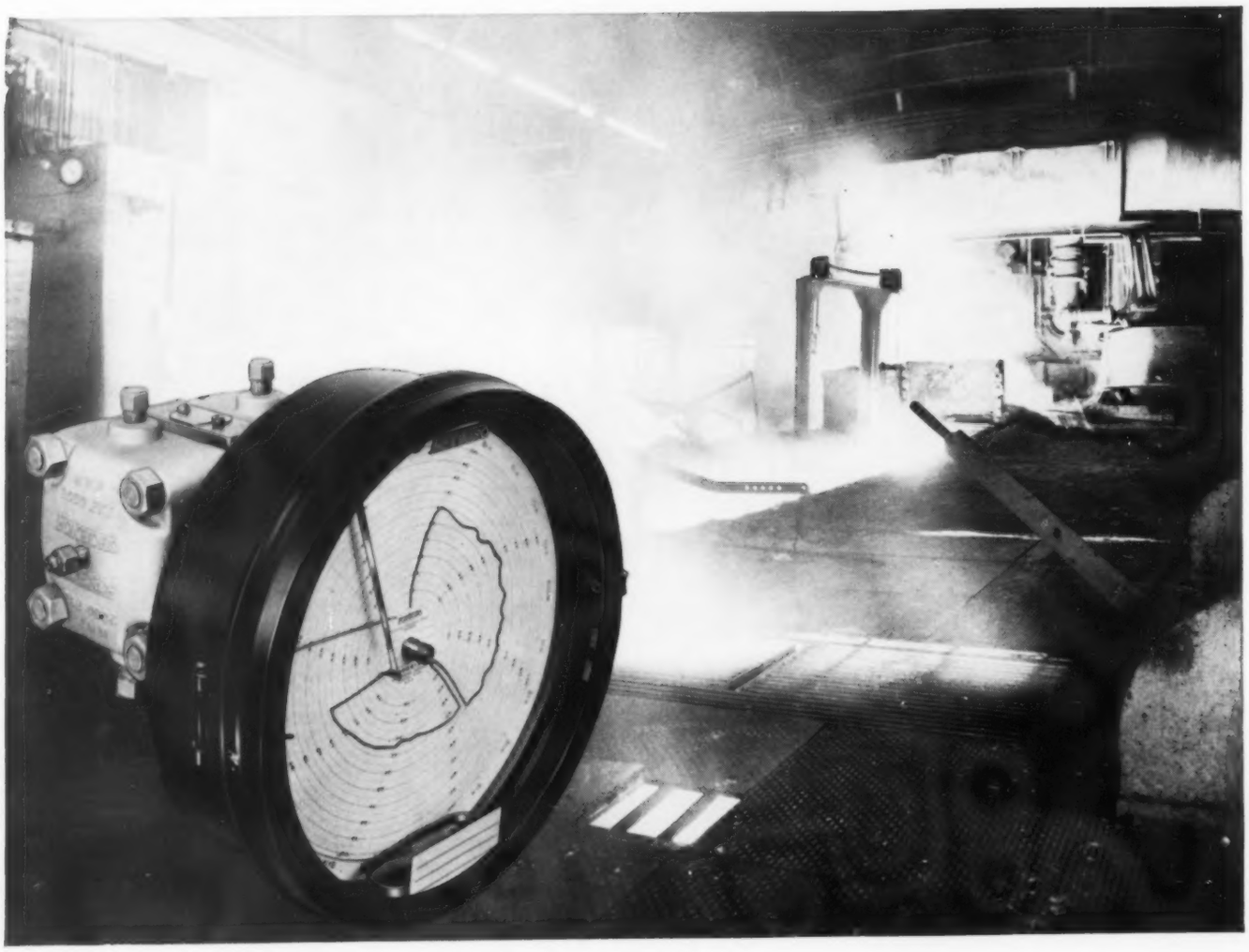
STREET_____

CITY_____ ZONE_____

COUNTY_____ STATE_____

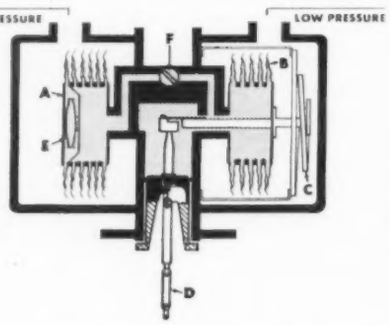
JOHNS-MANVILLE
REFRACTORY AND INSULATING REFRACTORY PRODUCTS

JOHNS-MANVILLE JM PRODUCTS



Dirty gas can't foul this flow meter

HOW THE DIAPHRAGM METER WORKS



In the schematic drawing above, areas shown in gray represent a stable, non-freezing liquid which never comes in contact with the process fluid. Any pressure increase in the high pressure chamber compresses diaphragm unit A, displacing its liquid and expanding diaphragm unit B until the force of range spring C equals the difference between the forces of the two diaphragm units. Linear motion of diaphragm unit B moves inner end of drive bar D — outer end moves correspondingly through the bellows – sealed flexure bar, driving pen arm.

Blast furnace gas, coke oven gas, natural gas, steam, water — you can measure them all with the Foxboro Type 37 Diaphragm Flow Meter and never worry about mercury contamination.

That's because the Diaphragm Meter has *no* mercury. In this meter, expansible Type 316 s.s. diaphragm elements convert differential pressure into accurate, dependable pen arm motion — automatically compensated for ambient temperature effects. There's no mercury to clean or replace — no loss of accuracy due to clogging.

Even with dirty gas, the exclusive design of the Foxboro Diaphragm Meter's range-springs and diaphragm elements assures lowest maintenance — highest sustained accuracy of any "dry" meter.

The Type 37 handles flow measurements over a wide range of differential pressures — at static pressures up to 2000 psi. Get full details by writing for Bulletin 7-15. The Foxboro Company, 587 Neponset Avenue, Foxboro, Massachusetts.

FOXBORO
REG. U.S. PAT. OFF.
***FIRST* IN FLOW METERING**

FOUR STRAND ROD MILL ROLLS RECORD

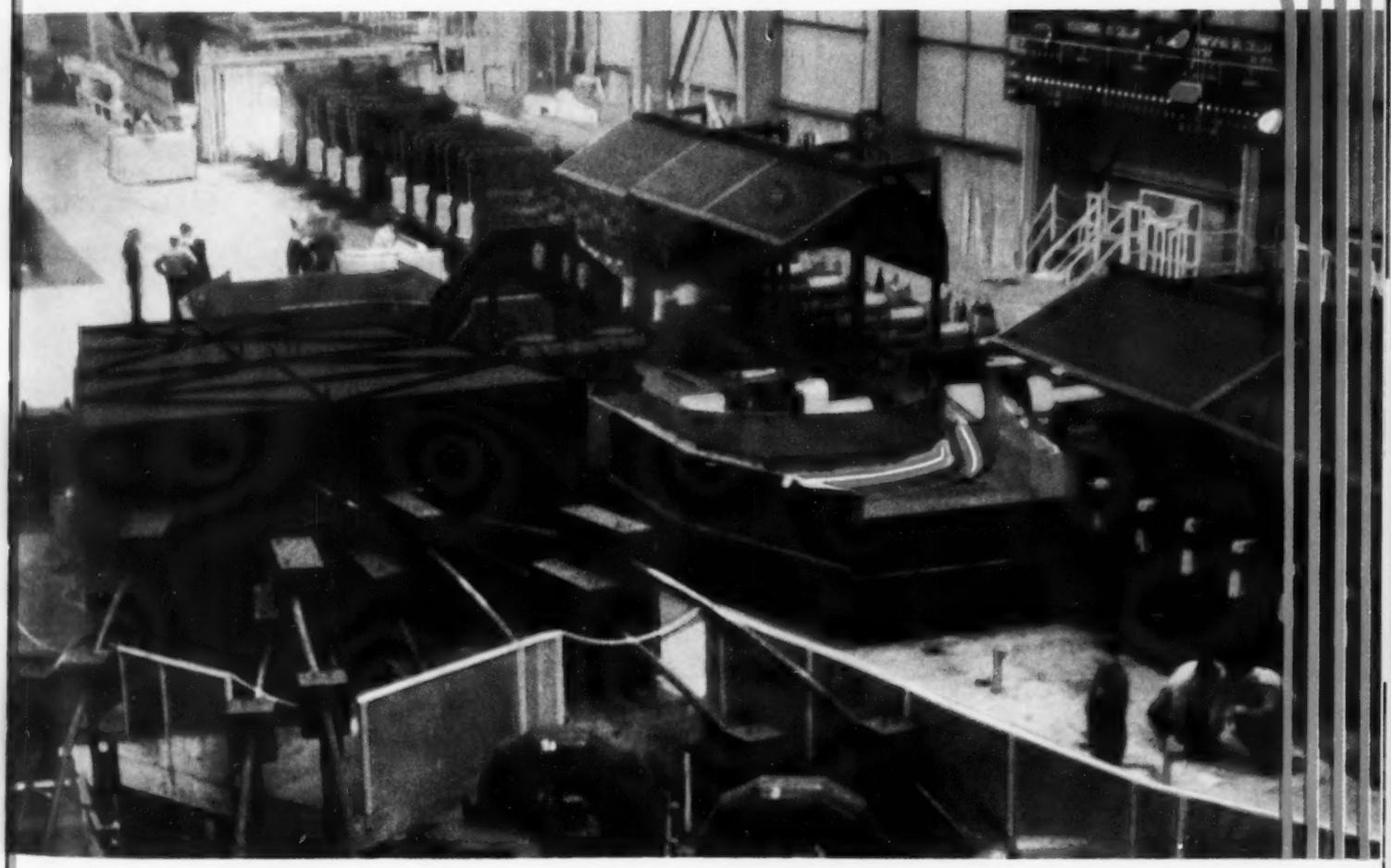
Providing a significant breakthrough in technical ceilings by rolling four strands at 6000 fpm, Morgan's No. 1 rod mill in the Cuyahoga Works of United States Steel Corporation's American Steel & Wire Division, Cleveland, Ohio, has been setting output records ever since start-up. Such outstanding productivity results from advanced engineering concepts incorporated in every Morgan design to assure maximum profitability through long years of service.

45,734 TONS OF ROD PER MONTH

551 TONS PER TURN FOR 83 CONSECUTIVE TURNS

2105 TONS IN 24 HOURS

11,399 TONS IN A WORK WEEK



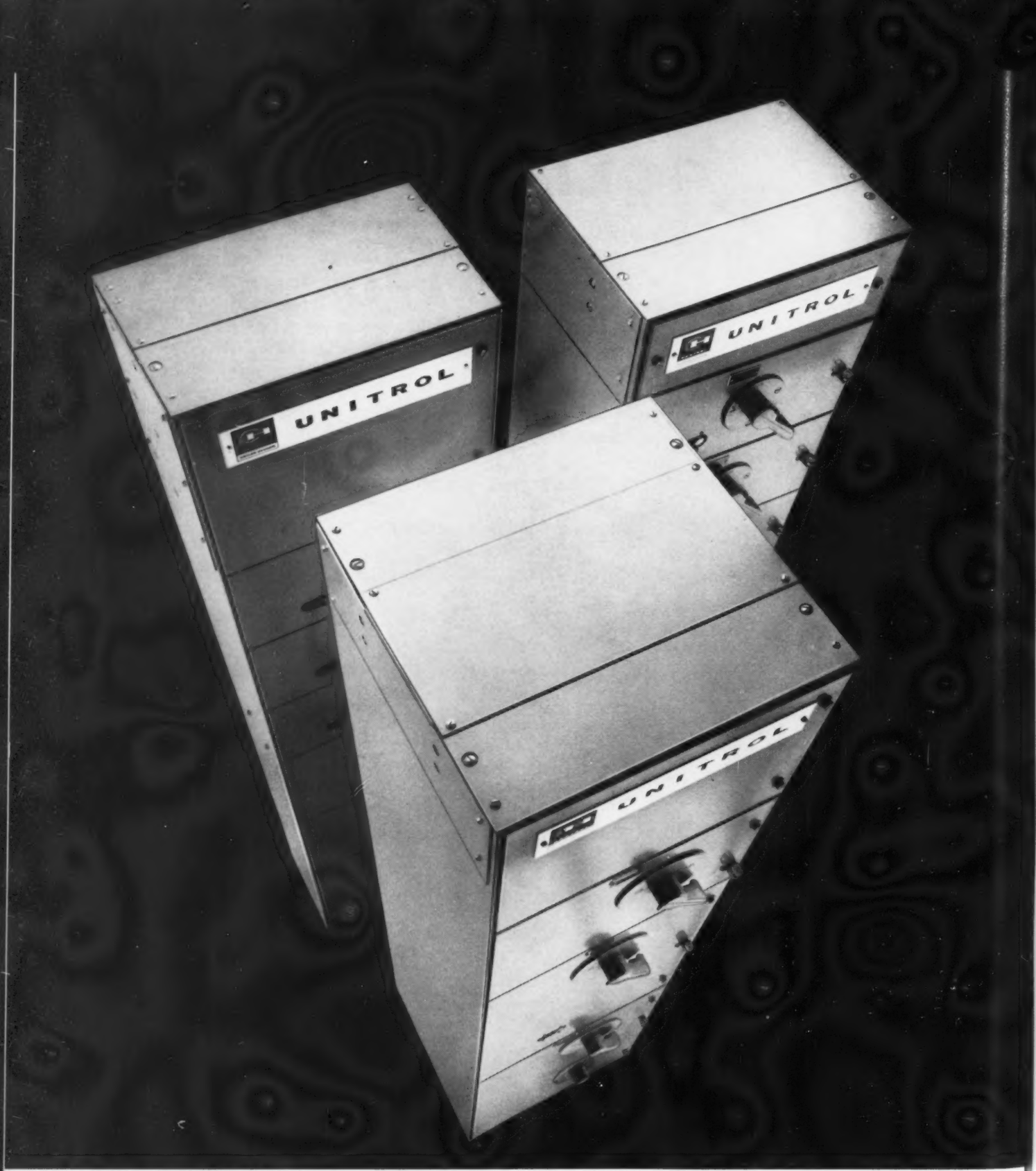
MORGAN WORCESTER

R2 © 1961

MORGAN CONSTRUCTION CO.

WORCESTER, MASSACHUSETTS

ROLLING MILLS • MORGOIL BEARINGS • WIRE DRAWING MACHINES • COMBUSTION CONTROLS



WHO ELSE BUT CUTLER-HAMMER GIVES YOU ALL THESE FEATURES?

- Quick and safe maintenance
- All front connections
- Tough baked enamel finish
- Completely safe wiring troughs
- Add options . . . no crowding
- Vertical bus silver plated
- Quick latch door fasteners
- Five padlock locations
- 100% interchangeability
- Positive off-power test position
- Modular construction

CONTROL

Now! Cutler-Hammer Unitrol in two new shallow depths!

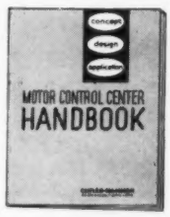
Get more compactness, more flexibility in motor control centers plus Cutler-Hammer dependability and safety

With Unitrol, you eliminate the high cost of mounting and wiring individual starters, as well as using far less space. Unitrol gives you flexibility, too . . . easy to change starters to fit needs and expand without disturbing other starter units. The two new shallow depths (15″ and 12″) make Unitrol practical even on catwalks or tunnels. Unitrol's modular design lets you put as many as 8 Size 1 starters in a single section and still leave room for many options.

But, probably more important is the safety factor built into Unitrol—safety for the men and machines. For instance, you can *lock* each unit in maintenance position for complete safety. Look at the features at the left for some of the extra values in Unitrol.

What's new at Cutler-Hammer? You can see the new spirit and vitality in a flood of new products and product improvements. Plant capacity has been increased. We've added new engineering talent to increase efficiency. Everywhere you look, you can see that we're ready to help you meet the challenge of the years ahead. Get the inside story from the Cutler-Hammer sales office nearest you.

NEW! FREE! BOOKLET: The "Motor Control Center Handbook" gives you practical facts on selecting the proper control as well as estimating for future needs. Send for Pub. LJ-1-N232 now!

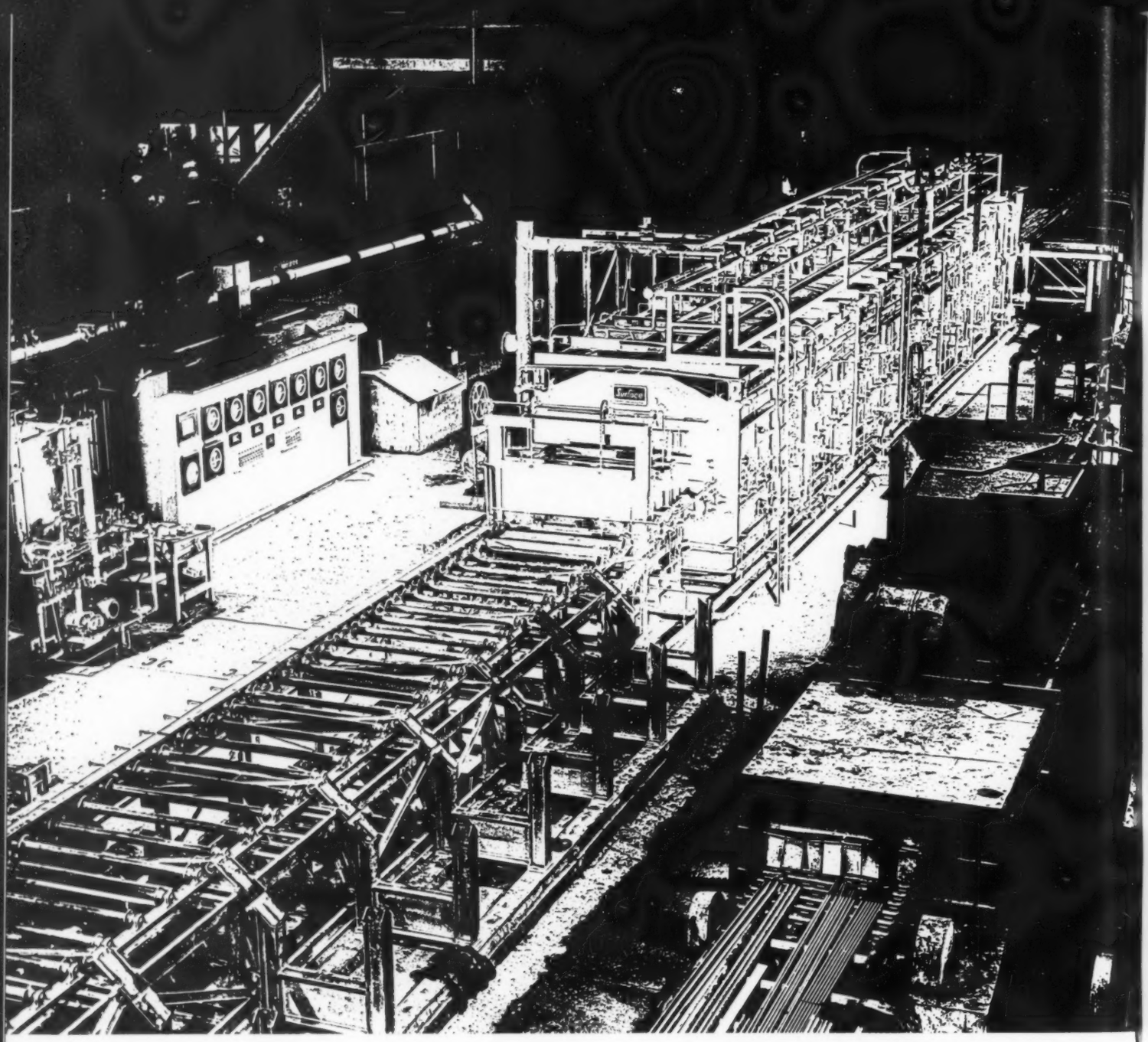


WHAT'S NEW? ASK...

CUTLER-HAMMER

CONTROL

Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. • Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.



Courtesy of Jones & Laughlin Steel Corporation

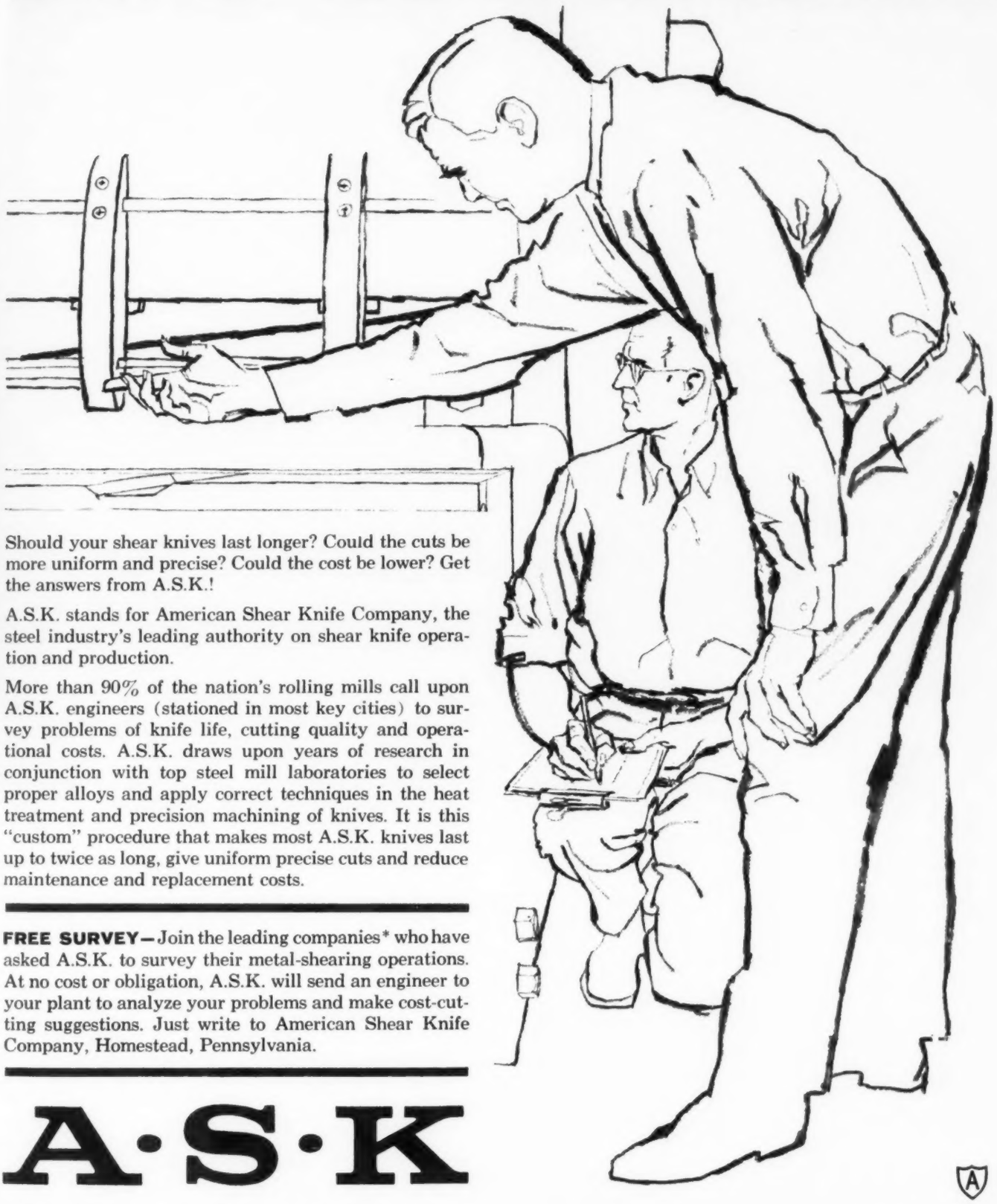
Produces more steel and happier customers: Both Jones & Laughlin Steel Corporation and its customers have gained from this Surface furnace. For J&L, it affords continuous high production, uniformity through every bar in each load, accurate repeatability, and a variety of heating-cooling cycles. For J&L's customers, it delivers bar stock with the uniform microstructure which improves machining efficiency and profits. Address inquiries to 2404 Dorr St., Toledo 1, Ohio.

SURFACE

SURFACE COMBUSTION, Toledo 1, Ohio/ a division of Midland-Ross Corporation MR

Can you get more wear from your shear knives?

A·S·K for the answer!



Should your shear knives last longer? Could the cuts be more uniform and precise? Could the cost be lower? Get the answers from A.S.K.!

A.S.K. stands for American Shear Knife Company, the steel industry's leading authority on shear knife operation and production.

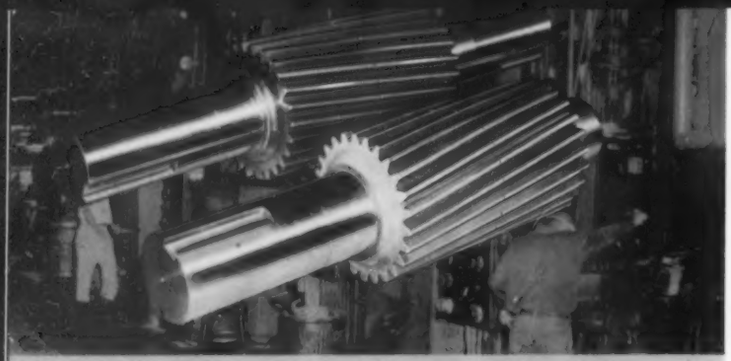
More than 90% of the nation's rolling mills call upon A.S.K. engineers (stationed in most key cities) to survey problems of knife life, cutting quality and operational costs. A.S.K. draws upon years of research in conjunction with top steel mill laboratories to select proper alloys and apply correct techniques in the heat treatment and precision machining of knives. It is this "custom" procedure that makes most A.S.K. knives last up to twice as long, give uniform precise cuts and reduce maintenance and replacement costs.

FREE SURVEY—Join the leading companies* who have asked A.S.K. to survey their metal-shearing operations. At no cost or obligation, A.S.K. will send an engineer to your plant to analyze your problems and make cost-cutting suggestions. Just write to American Shear Knife Company, Homestead, Pennsylvania.

A·S·K

AMERICAN SHEAR KNIFE

**names supplied on request*



TSP mill pinions drive 56" four stand cold reduction mill.

THREE REASONS WHY GRANITE CITY STEEL HAS SINCE 1918

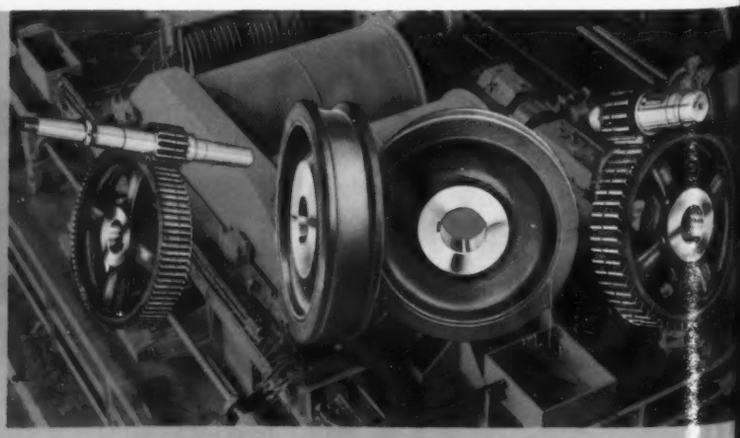
TSP edger screws on hot strip mill.

1. THEY LAST LONGER than any other product in the same service. TSP hardening results in a file hard surface to the full depth of permissible wear for maximum life. A core, refined for toughness and ductility, gives maximum strength.

2. THEY SAVE MONEY because of their phenomenally long wear qualities. TSP hardened products seldom need to be removed from your machine for maintenance or replacement. The countless thousands of dollars that have been saved by major steel companies in both maintenance and replacement is a basic reason for their wide usage.

3. THEY ARE GUARANTEED in an exclusive written guarantee to outwear any other competitive product in the same service. This unique guarantee that accompanies every TSP product could only be successfully made on a superior product. Of the thousands and thousands of TSP products sold, it has been seldom necessary for any company to call upon this guarantee.

TSP screwdown screws and nuts on 45" blooming and slabbing mill.



TSP wheels and gearing on 325 ton ladle crane.

TSP track wheels and gears on coke pusher.

TOOL STEEL PROCESS products have been purchased by Granite City Steel Co., Granite City, Ill. since 1918. This continuous confidence in the quality of TSP products is a superb recommendation from one of the nation's great steel companies. TSP products are in use in every department. They include screwdown screws and nuts, gears and pinions, track and sheave wheels, leveller, pinch, back-up and coiler carrying rolls, arbors, shafts and axles, sprockets and mill pinions. Write for TSP Bulletin for the Steel Industry.

THE TOOL STEEL GEAR & PINION COMPANY

CINCINNATI / OHIO / USA

the standard of quality since 1909 for gears ■ pinions ■ rolls ■ wheels and other hardened products.

MEMBER OF AGMA

TSP rolls on processing and shearing line.

TSP sheave wheels on slab yard crane.

AD 1051 Printed in U.S.A.

BADALL ROLLS

CUT REPLACEMENT COSTS AT GRANITE CITY STEEL

BADALL HARDENED STEEL ROLLS replaced 90 cast iron rolls on Granite City Steel's hot strip runout table in 1955. All Badall rolls are still in service. No replacement has been necessary due to roll breakage, warpage, high temperature deterioration, galling or oxide pick-up, normally experienced with cast iron rolls. Badall rolls have resulted in substantial savings in downtime and replacement costs.

The 10" Badall rolls used are of carbonitrided steel, tubular design with 1½" wall thickness. A steel shaft runs through center. The comparatively low cost plus exceptional long-wear qualities make Badall rolls a wise investment. For technical data on heat treating and manufacturing of Badall rolls, write for Bulletin B-160.

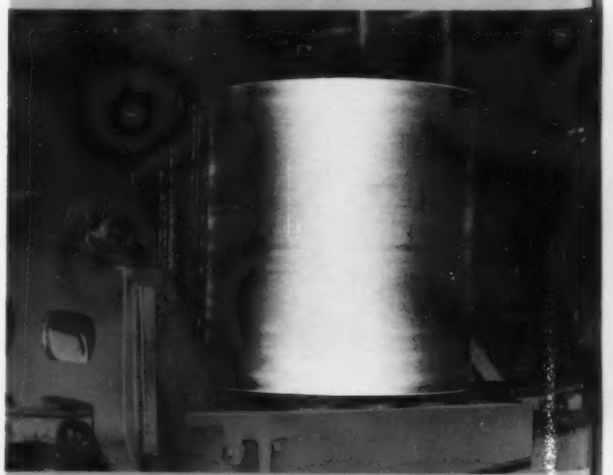
THE BADALL COMPANY, INC.

HAMMOND, INDIANA

A wholly owned subsidiary of The Tool Steel Gear and Pinion Co. / Cincinnati / Ohio / U.S.A.

There are 159 rolls in this table. Only about half of the table is equipped with strip cooling water spray.

Hot strip mill, Granite City Steel Company. A hot strip over the Badall runout table rolls.



Thousands of coils of strip steel are turned out on Granite City's hot strip line equipped with Badall rolls.

don't push this !

Call Ma Ma*

Anticipate your parts problems! Let MA MA bid the next time! MA MA builds original parts, replacement parts and accessories for Mill-Type equipment. In fact . . . when it comes to building equipment there isn't much that MA MA can't do! Let MA MA bid . . . you'll be pleased to find out how thrifty we are with your money and how fast we are with delivery.

***MA MA is an easy name to remember. It stands for MAchinery-MAintenance Division, Coronado Steel Company. MA MA's phone number is 747-4436.**

CORONADO STEEL CO.

MACHINERY • **MA**INTENANCE DIV.
WEST COMMERCE AND NORTH AVE.
YOUNGSTOWN 3, OHIO • PH. 747-4436

FOR YOUR VERY OWN PANIC BUTTON FILL IN THIS COUPON TODAY! (Button has self-stick backing and will fasten on any surface.)

Coronado Steel Co., Machinery-Maintenance Division
West Commerce and North Avenue
Youngstown 3, Ohio

Name_____

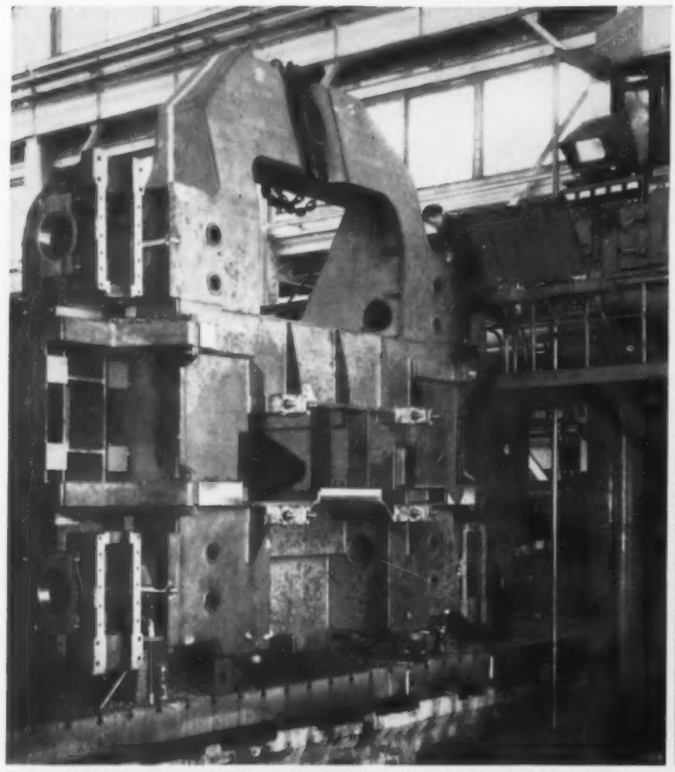
Title_____ Dept._____

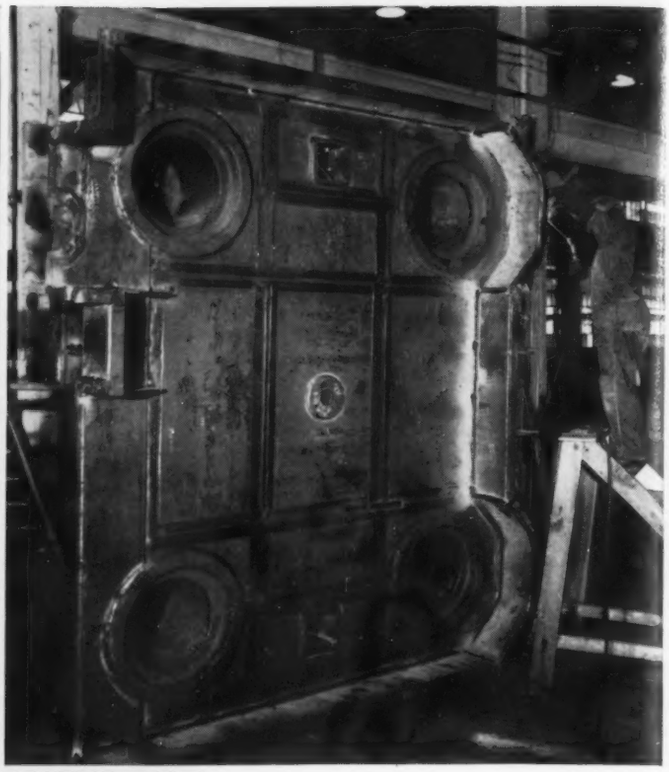
Company_____

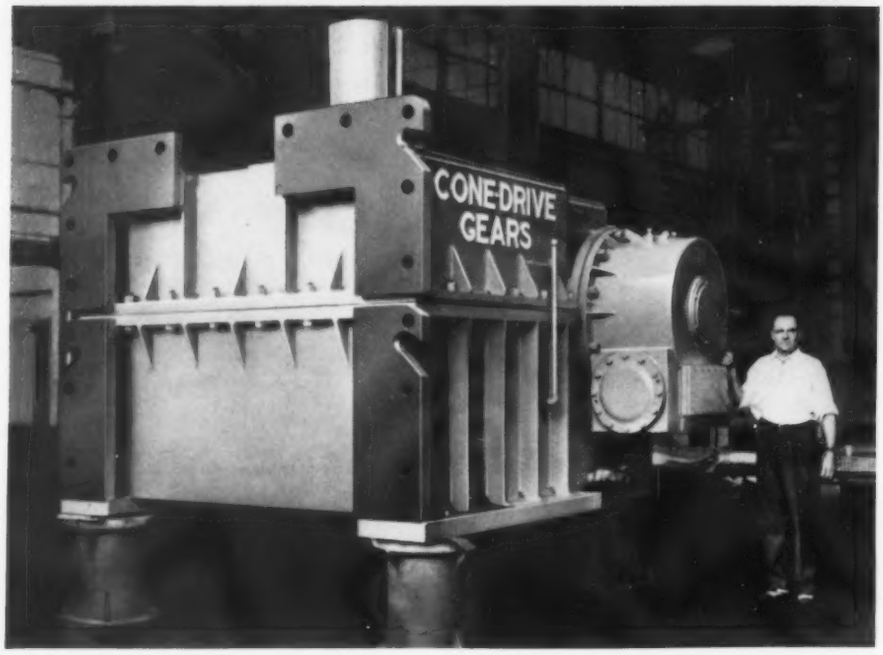
Address_____

City_____ Zone_____ State_____

Dept. B







How Morgan weldments can solve problems for you!

The nationally known facilities, experience and craftsmanship of The Morgan Engineering Company are available to produce components for your products. Whether you need small weldments in quantity, or large parts like these, you can subcontract this part of your production profitably and confidently.

Inspection of our plant is welcomed. Write, wire or phone for complete information—or ask a Morgan sales engineer to call.

ELECTRIC OVERHEAD CRANE INSTITUTE EOCI MEMBER

THE
MORGAN
ENGINEERING CO. *Alliance, Ohio*

Overhead electric traveling cranes, gantry cranes, open hearth special cranes, plate mills, blooming mills, structural mills, shears, saws and auxiliary equipment.

How to automate step by step

Automation means many things to many people . . . ranging from the simple sequencing of individual operations to the completely automatic system.

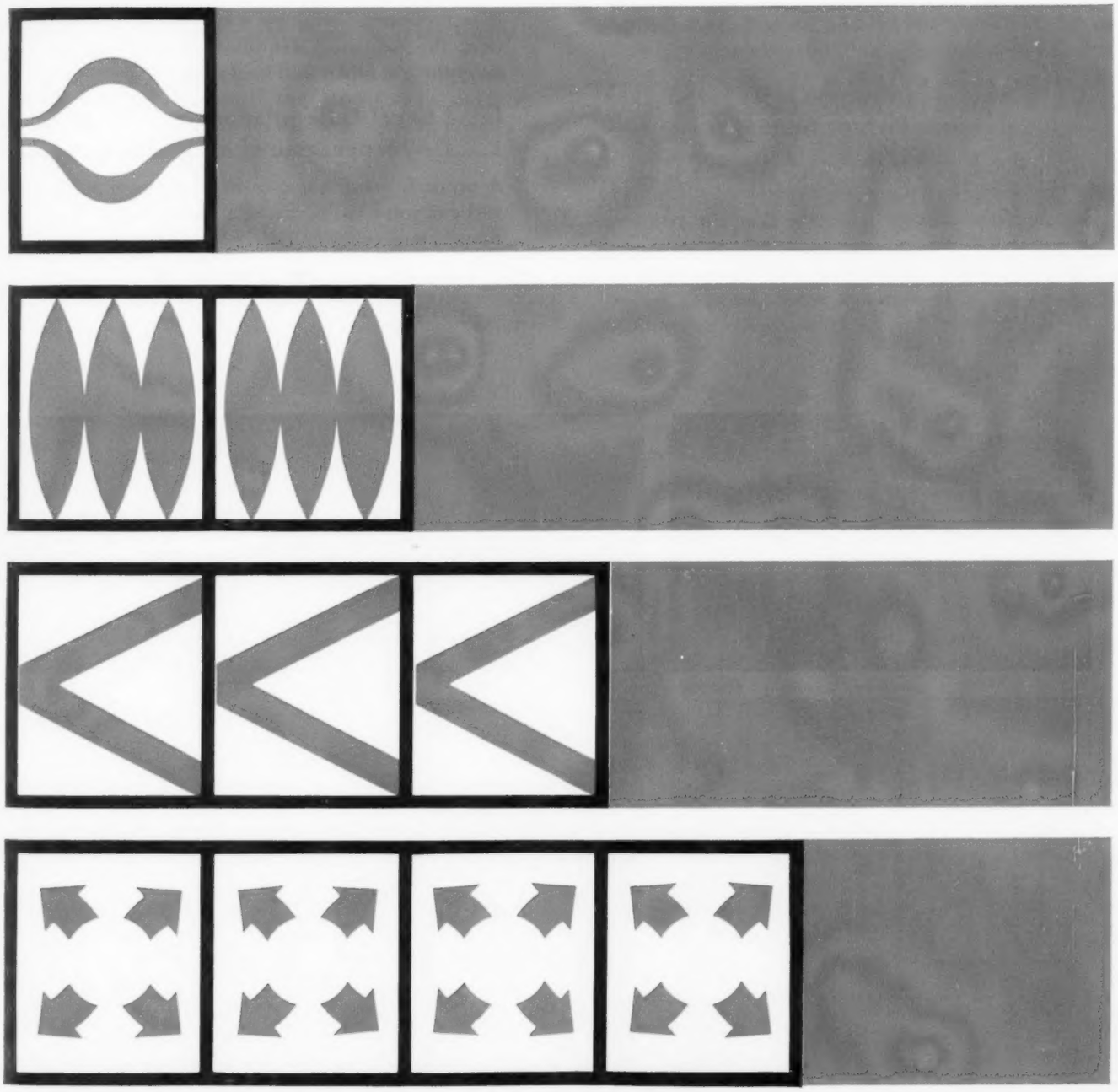
Westinghouse has chosen the term "Progressive Automation" to describe a step-by-step application and coordination of electric drive systems . . . executed in stages that are completely compatible to your cost-reduction, production quality and equipment modernization goals.

Such a step-by-step concept permits you to realize immediately higher mill rates, better steel quality and longer mill equipment life in those individual operations that are initially automated . . . and at the same time, moves you a big step closer to the full profit and production benefits of completely automated facilities.

Westinghouse, the leader in this field, is ready to work with you at whatever level you are currently concerned with . . . from simple process regulation to ultimate continuous decision-making computer control.

What level of Westinghouse's "Progressive Automation" meets your current needs best? Let's examine the definitions on the following pages . . .

Westinghouse



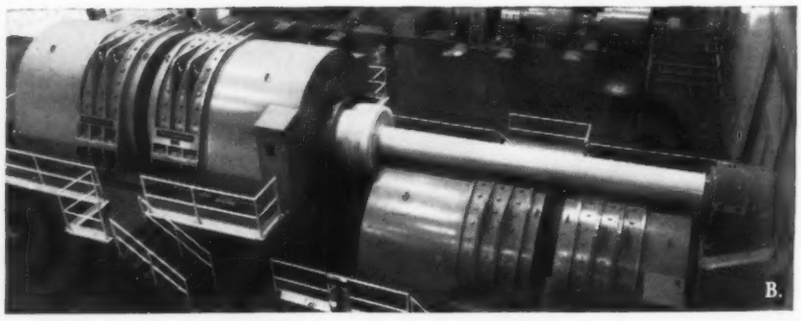
Westinghouse can help you plan the levels best for you . . . apply them as fast as you want

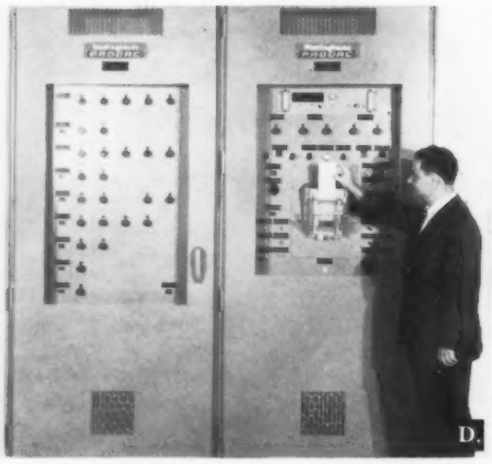
To properly relate your current operations to the Westinghouse "step by step" approach to automation, the following definitions have been developed for your guidance and evaluation:

Level I. Regulation and Gauge Control —cornerstone of automation

A properly coordinated team of power supplies, motors and controls—the operational muscles and brains—continually supervises and corrects process variables such as voltage, tension, speed, torque, position, dimensions and temperatures . . . for better product quality, greater productivity.

A.


B.


D.

E.

Level II. Programming—the right action at the right time automatically

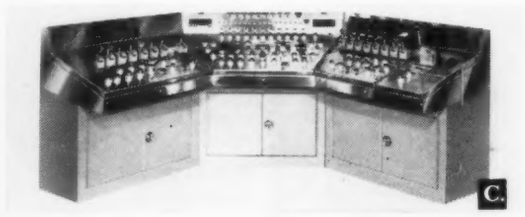
Pre-selection, by means of information contained on punched cards, tapes or manual setups, of the sequence of events and information needed by the regulating system, to control the process.

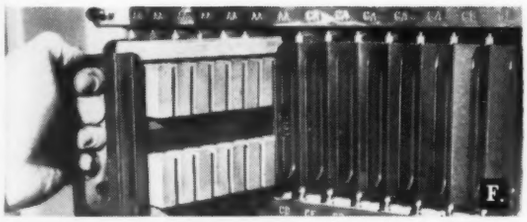
Level III. Data Logging—fast, precise information

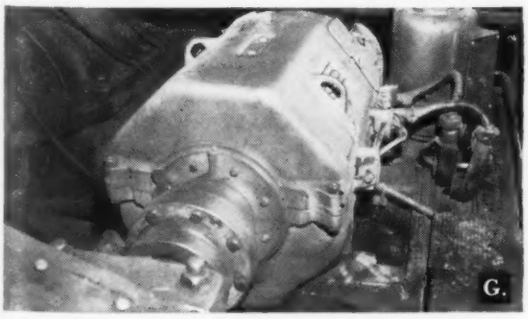
Automatic collection and storage of operating and process information for use when needed—in the form needed. Data logging and display can provide immediate production data for quality control, etc., can record information required to re-program, and can operate as part of a computer in monitoring and optimizing mill performance.

Level IV. Computing—management control through automatic decision making

Continuous decision-making computer control which optimizes the mill operation by constantly monitoring and correcting the programming and regulatory systems. These corrections are required because of changes in process elements, environmental conditions, equipment loading, and other variables.


C.


F.


G.

Westinghouse products permit you to realize optimum results at every level of automation

A. Westinghouse Life-Line® motors and Moduline® gearing installed in cleaning section of 50-inch continuous annealing line.

B. Mill muscles are dependable Westinghouse motors with exclusive Thermalastic® insulation on armatures. This 12,000-hp twin drive is conservatively rated . . . designed for rugged rolling mill duty.

C. Typical operator's control pulpit for computer controlled mill.

D. Input portion of data accumulation system with manual switches on left—punched card reader on right.

E. Complete automatic mill operation is possible with Westinghouse on-line industrial Prodac* control computer.

F. Prodac module, representing a circuit function, is easily accessible for removal or replacement.

G. Westinghouse heavy-duty d-c mill motors provide power for toughest applications. On steel mill screwdowns, improved field coil design adds more copper for greater capacity and longer life.

For other considerations affecting your use of Westinghouse *Progressive Automation*, see the next page . . .

*Trademark

Westinghouse

How to apply Progressive Automation to your mills

Exactly where and how can you begin to blue-print your over-all automation plan that will reap all these benefits for your production? The best answer is to begin with the best qualified scource: Westinghouse, who has designed, built and installed more automatic production systems in steel mills than any other manufacturer.

Westinghouse—one source, one responsibility

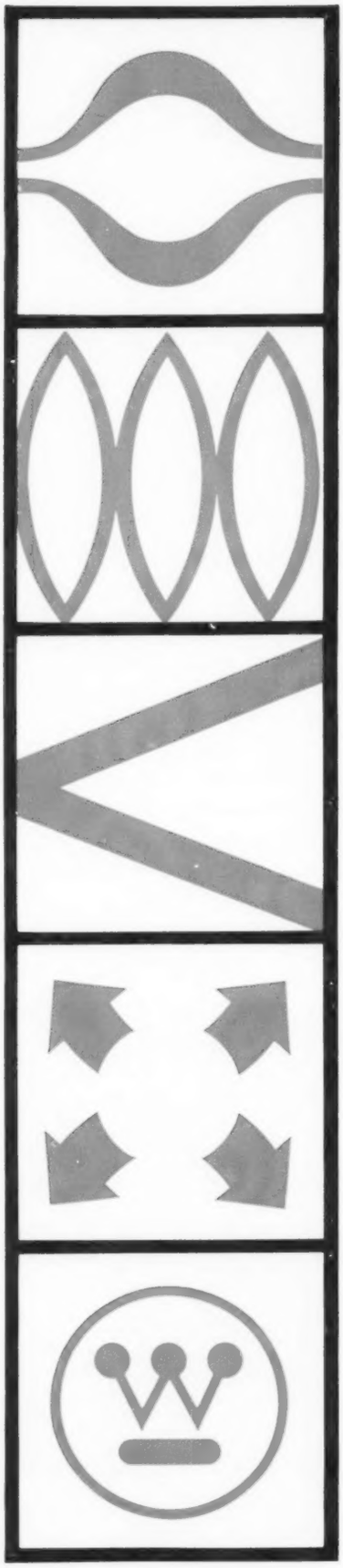
Westinghouse experience, facilities, engineering talent and equipment add up to your assurance of:

1. A sound analysis of your automation needs to determine the automatic systems best suited to your processes.
2. A coordinated systems approach of motors and controls, thoroughly engineered and completely tested, which integrates the stages of automatic production you need.
3. An automatic control system designed for application to your mill in line with the Westinghouse concept of *Progressive Automation.*
4. The use of the latest automation techniques and components—all adaptable to future developments and needed expansion.
5. A single source, a single responsibility for complete automation systems and related electrical equipment.

These complete Westinghouse facilities are available to you. Call your nearby Westinghouse representative, or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania.

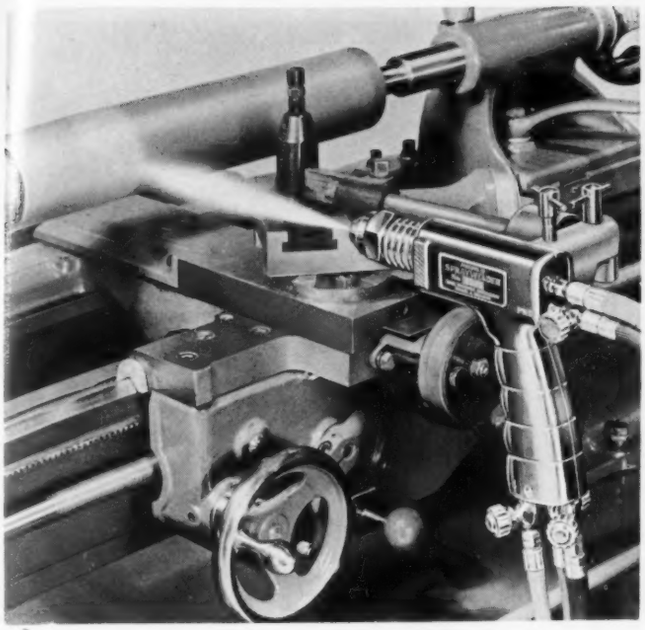
You can be sure . . . if it's Westinghouse

Westinghouse



Interested in more information on Westinghouse Progressive Automation for the steel industry? Write for B-8220, a complete set of new brochures describing Automation "steps" in detail as they relate to steelmaking operations. You can reserve a set for your use by indicating your area of interest on your company letterhead and mailing it to: Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa.

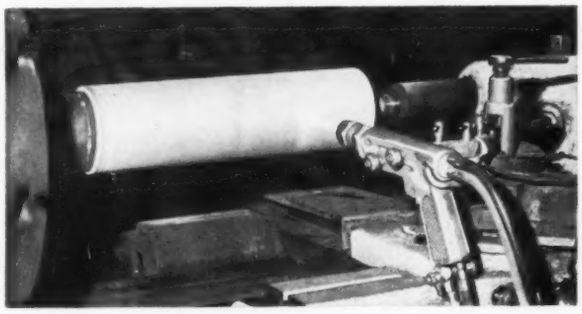
J-96173-1-A



SPRAYWELD® Hard Surfacing Cuts Journal Costs

Table roller journal sleeve maintenance costs were cut from $21.06 to only $1.50 each per month through the use of the Colmonoy Spraywelder (reports the September 1957 issue of *Iron and Steel Engineer*). The Spraywelder, a universally accepted powder metal spraying unit, applies Colmonoy hard-surfacing alloys to provide low-cost protection against abrasion, impact, heat, and corrosion.

The Colmonoy Spraywelder sprays powdered Colmonoy alloys to form smooth, even overlays. The overlays are then fused to the part, forming an integral surface of wear-resistant alloy. Write now for complete information about this versatile maintenance tool.



Journal sleeves are made of low carbon seamless steel tubing, with an overlay of Colmonoy No. 6 hard-surfacing alloy, applied by the Spraywelder. The sleeve is rotated in a lathe, with the Spraywelder mounted in a tool-post holder.

HARD-SURFACING & BRAZING ALLOYS

WALL COLMONOY CORPORATION

19345 JOHN R STREET • DETROIT 3, MICHIGAN

Buffalo • Chicago • Houston • Los Angeles • Morrisville • New York • Pittsburgh • Montreal • London, England

* SPRAYING SYSTEMS CO.

* DESCALING NOZZLES

* **compact**
modern design . . . only ½ to ⅓ the size of old nozzle types

in hardened stainless steel

* **advanced hydraulic design**
gives extremely sharp, hard hitting FLAT SPRAY pattern

in stainless steel with tungsten carbide orifice tips

* **large open orifice**
keeps clogging to a minimum

Here are spray nozzles with sharp, high-impact flat spray patterns to materially improve your descaling operations. They're small in size for easier installation and better performance. The unusually large orifices go far in solving clogging problems. Made in all capacities in hardened stainless steel for high resistance to sand and silt. And for maximum possible abrasion resistance, they're also made with Tungsten Carbide orifice inserts. Just write . . . we'll be happy to send you complete Descaling Spray Nozzle information.

HEAVY DUTY LINE STRAINERS

Spraying Systems now offers line strainers in a full range of sizes . . . with threaded connections up to 4″ N.P.T. size . . . and flanged connections in 3″, 4″ and 6″ pipe size. Designed for operation at pressures up to 125 psi. Unusually large screen areas for high volume capacity. Heavy duty, reinforced screens. Easily flush-cleaned through bottom plug or drain cock. Write for Bulletin 94.

SPRAYING SYSTEMS CO.

3262 RANDOLPH STREET • BELLWOOD, ILLINOIS

THERE'S A TIMKEN® BEARING TO FIT EVERY NEED

30 types and over 10,247 sizes make Timken bearings the most complete line of tapered roller bearings.

The little bearing you almost missed sitting there on top of the big one is too small to fit on your little finger. It's used in the reel of a power mower, and it weighs only 2.6 ounces. The big one is a four-row mill roll-neck bearing, weighing over six tons.

Between these two extremes you'll find a Timken® tapered roller bearing to fit every combination of radial and thrust loads, for all kinds of mountings, and for virtually all operating conditions. This most complete line of tapered roller bearings is sold and serviced by graduate engineers who can help you select the one bearing, from hundreds of possibilities, that will give you the most for your bearing dollar.

Make sure you check with your Timken bearing representative. He can tell you which bearing is the most economical for your application. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits. Canadian Division: Canadian Timken, St. Thomas, Ontario.

On the spot engineering service with...

TIMKEN®
tapered roller bearings

. . . Then There Were Two!

Remember this story about the DUCKS?

"In February 1953, eight soaking pit covers were experimentally installed in new pits at an eastern steel mill.

4 covers were—Superduty Firebrick
1 cover was—Insulating Firebrick
1 cover was—3000° F. Castable
2 covers were—
Special Super Ramtite No. 25 Construction

"Six of these covers were soon dead ducks! One after another, the insulating firebrick, castable and superduty firebrick were replaced with RAMTITE."

This ad was run in 1956 when the two RAMTITE-lined covers, after three years service, were still *LIVE* Ducks and flying high. *

*These two live ducks, with minor maintenance, gave service for five and seven years respectively.

The Case of TWO DUCKS Which Outlived Six Others

Sequel

NOW 118 SOAKING PIT COVERS

Again proving that "THE BEST SIGN OF SATISFACTION IS A REPEAT ORDER" — there are now 118 Soaking pit covers in this Eastern steel mill on the job. This is a gratifying example of the high flying performance of RAMTITE.

Moral DON'T HAVE DEAD DUCKS!

"There's a RAMTITE® Product for Every Refractory User."

The Ramtite Co.
DIV. OF THE S. OBERMAYER CO.
1813 S. Rockwell St., Chicago 8, Illinois

THE RAMTITE CO., Div. of the S. Obermayer Co.
1813 S. Rockwell St., Chicago 8, Illinois
Please send:

- ☐ Information on use of RAMTITE in Soaking Pits
- ☐ Your new folder on Open Hearth Furnaces
- ☐ General Information about RAMTITE Products
- ☐ Representative (without obligation)

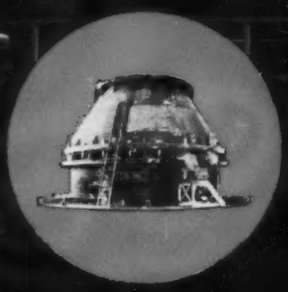
Company Name_____
Attn. Mr._____ Title_____
Address_____
City_____ Zone____ State_____

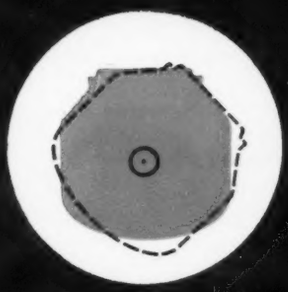
A roll's life holds no secrets

Men like National's metallurgist Joe Marsalka see to that. Before your roll is born, National helps select the proper composition, grade and hardness. As it is being produced, our metallurgists carefully control chill locations, pouring procedures and heat treatment. When the roll is "full-grown" ultra-sonic testing equipment checks its internal soundness making sure your roll is ready for the tough life ahead. Even after your roll is shipped, National keeps in touch with its performance in your stand. This intimate knowledge of roll life is one reason we are able to consistently produce quality steel, iron and nodular iron rolls. It's a big reason why... NATIONAL'S THE GROWING NAME IN ROLLS.

NATIONAL ROLL & FOUNDRY DIVISION
GENERAL STEEL INDUSTRIES, INC., Avonmore, Pennsylvania
General Steel Industries, Inc., General Offices: Granite City, Ill. Plants: Granite City, Ill., Eddystone, Pa., Avonmore, Pa.
Subsidiary: St. Louis Car Company, St. Louis, Mo.

in oxygen converters . . .





Top: 110-ton capacity furnace (L-D) with PECor-engineered smoke hood and post crane, at McLouth Steel Corporation.

Center: World's largest oxygen furnace (L-D) during assembly, for Jones & Laughlin's Cleveland Works.

Bottom: All PECor drives are soundly made for assured trouble-free service.

YOU GET FAR MORE THAN THE VESSEL FROM PECOR

QUALITY in design and manufacture, reflecting unique experience and constant contact with operating L-D installations. Precision engineered auxiliaries!

RELIABILITY, equipment that "stays on the line" making steel.

SERVICE, including *immediate response* to field requirements, with service as close as your telephone.

May we consult with you in the planning stage?

Pennsylvania Engineering CORPORATION NEW CASTLE, PA.

Sales Representatives: Wooldridge Company, Burlingame and Los Angeles, Calif.
Fred Middleton Co., Inc., Birmingham, Ala.

Licensees: Ashmore, Benson, Pease & Company, Ltd., Eng.
Kawasaki Dockyard Company, Ltd., Japan

BUILDER OF AMERICA'S FIRST 15 OXYGEN CONVERTERS

HOW MUCH automatic control ...and WHEN?

BAILEY 700 SYSTEMS can help you make sure . . . with step-by-step benefits

Many important — and profitable — improvements in steelmaking operations can be accomplished with analog and digital computer equipment.

Too much, too soon, however, can be costly — as can too little, too late. Intermediate stages of refinements in measurement and control are desirable and necessary. These not only can produce substantial benefits, but can demonstrate the additional improvements possible with further—or ultimately complete—automatic control. Bailey step-by-step automation assures against loss of prior investment.

Bailey engineers can help you determine optimum usage of *Bailey 700 Analog and Digital Systems* in your operations. They are equipped, by broad experience, to provide single-source responsibility from sensing and measuring instrumentation to complete automatic control. *Bailey 700 Systems* are installed, in operation, or on order, at locations from coast to coast.

Find out what this Bailey experience can offer you. Contact your Bailey District Office.

Where Bailey 700 Systems can aid steelmaking operations

SINTERING — to achieve maximum quantity and quality of output at lowest cost.

BLAST FURNACES — to provide lower coke rates and higher yields.

OPEN HEARTH — to increase production and control delays.

OXYGEN CONVERTERS — to maintain product quality at highest production rates.

PLANT UTILITIES—to reduce power and fuel consumption while still meeting plant requirements.

S122-1

IRON AND STEEL DIVISION

BAILEY METER COMPANY

1047 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS

TRANSFERS - DEPILERS - PUSHERS
For 40,000 lb. Slabs at Youngstown Sheet & Tube Co.

Designed and built by

PITTSBURGH
ENGINEERING & MACHINE DIVISION

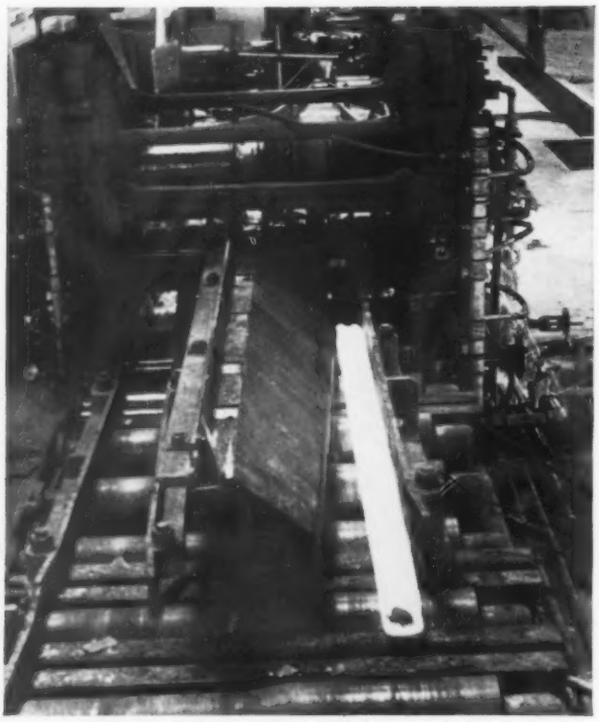
pittsburgh steel foundry • a textron company

Electric and open hearth steel castings from 1 lb. to 100 tons

564 FORBES AVE., PITTSBURGH 19, PA. • PLANTS AT GLASSPORT AND McKEESPORT, PA.

New **BIRDSBORO** mill breaks the "billet barrier"

rolls bars directly from ingots



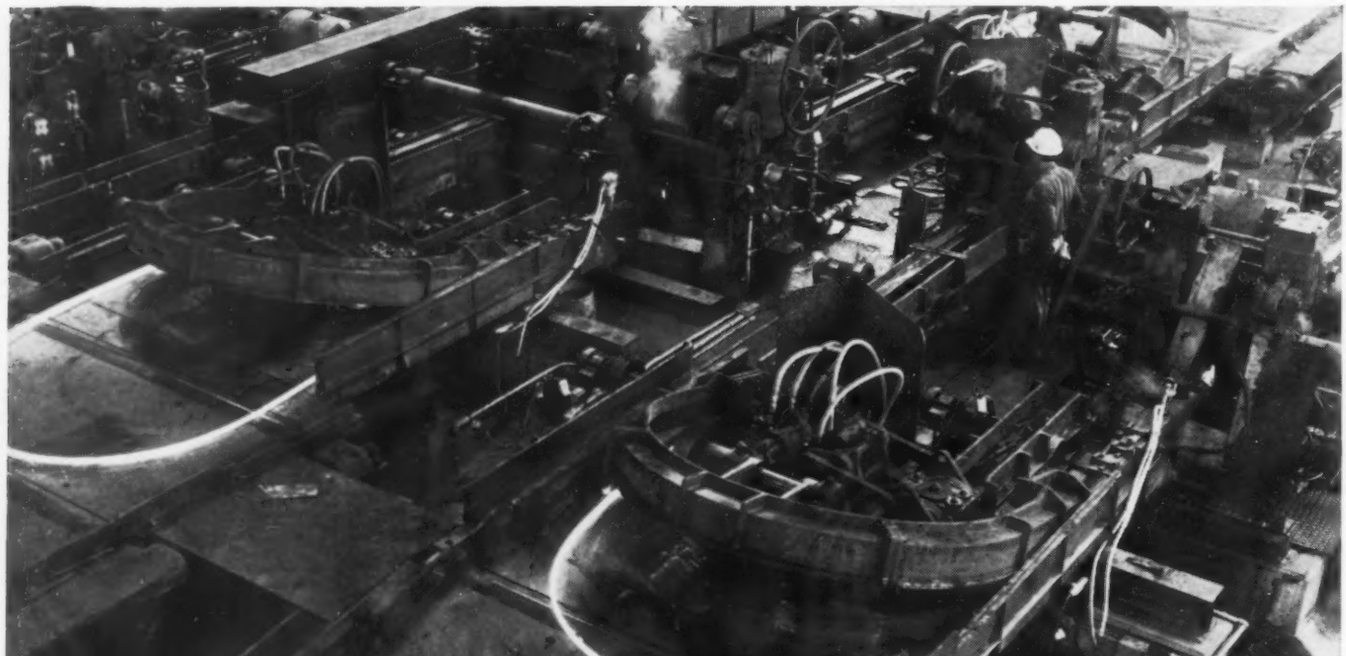
Ingot enters final pass in roughing stand

■ Bypassing the billet stage—a long-sought metal-working goal—has recently been accomplished by the Ceco Steel Products Corporation. From electric steel ingots cast billet-size, Ceco *direct rolls* finished bars on their new Birdsboro rolling mill.

The unique ingots are cast in three sizes, ranging from 322 to 990 lbs. The largest measures $7\frac{9}{16}''$ x $6\frac{9}{16}''$ x 6′; the smallest 5″ x 4″ x 5′. With these ingot sizes, the versatile Birdsboro mill produces rebars, angles, rounds and flats with a minimum of roll changes.

This 14-stand mill, the first of its kind, opens new areas of economy for many manufacturers. If you are considering new bar capacity in a plant of limited capacity, you may well be one of them. Why not call your Birdsboro representative and see? *Sales Department, Engineering Department & Mfg. Plant:* Birdsboro, Pa., *District Office:* Pittsburgh, Pa.

Reinforcing bar whips through repeaters

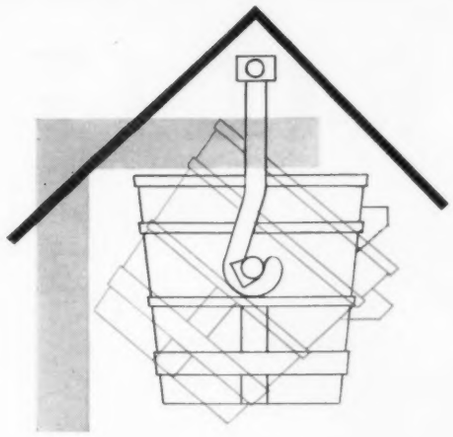


MM96-60

BIRDSBORO

CORPORATION BIRDSBORO, PENNA.

STEEL MILL MACHINERY • HYDRAULIC PRESSES • CRUSHING MACHINERY • SPECIAL MACHINERY • ROLLS • ELECTRIC STEEL CASTINGS: Carbon, Low Alloy and STAINLESS STEEL



STEEL ANGLES

THE need to modernize our productive facilities and eliminate the burden of obsolete machinery and equipment is one of the most important tasks facing American industry. This has been recognized for some time by industrialists, large and small, who have made common cause for some change in the tax laws which would give them adequate depreciation charges before taxes to replace plant and equipment.

The modernization of industrial facilities is also a prime objective of the Administration in Washington. In his tax message, President Kennedy discussed a proposal based on a tax credit which was intended to induce and aid industry in making the necessary expenditures, not only for the replacement of plant and equipment, but also for expansion. The President stated that the adoption of the proposed incentive would in no way foreclose later action on other aspects of depreciation which are presently under review by the Treasury Department as part of the over-all tax reform study. This is indeed fortunate for a tax credit does not come to grips with two fundamental aspects of the depreciation problem which involve:

1. The lack of funds for the replacement of plant due to the inflationary trend we have experienced in post-war period.

2. The rapid rate of obsolesence caused by a constantly improving technology.

It is certainly desirable that any plan to amend the tax laws should deal with these two problems. A proposal has already been made to solve the first. In essence, it allows a company to recover the purchasing power of its original investment provided this is reinvested in new plant and equipment. Thus, when depreciable property is sold or scrapped, the difference between the original value of the property and its value in current dollars can be written off, only if the money is reinvested in new facilities. This proposal helps provide—before taxes—the funds needed for modernization.

The second problem has been attacked by another proposal which would allow the taxpayer to choose any life he wishes for depreciable property provided that it is not less than five years for new plant and facilities. This method takes cognizance of the rapid obsolescence due to technological change and tends to eliminate disputes between the Internal Revenue Service and the taxpayer concerning facility lives.

The question of economic life as opposed to physical life is one that must be faced squarely. Many of our facilities are in fit physical condition for operation, yet they are economically obsolete because the changes in technology have provided us with new and better methods of production. This can be exemplified in many instances in the steel industry where facilities installed in the first 25 years of this century, which have been kept in good repair, are often capable of producing a suitable product. However, the cost of operation of these facilities may be as much as $10 to $15 a ton more than their modern counterpart. Consequently, they may be physically operable, but economically they are obsolete, and if a company fails to replace them it soon finds its profit margin reduced considerably.

In the discussion on tax reform to provide adequate depreciation, some have been concerned with the loss of tax revenue that might be sustained by the Treasury. In fact, in his testimony, Secretary Dillon estimated the President's plan would cost the Treasury $1,700,000,000 in revenue. This figure can be questioned because Mr. Dillon also stated that a plan, which would provide for the replacement of old with modern equipment, would also create a minimum of 500,000 new jobs. If we assume that the annual income from each of these jobs is between $4000 and $5000 a year, the aggregate amount of new income would be between $2,000,000,000 and $2,500,000,000. Personal income tax on this amount, as well as the corporate taxes generated by a higher level of business activity, would go a long way to offset any revenue loss. In fact, it is quite conceivable that this might wipe out the deficit completely. Thus it seems that depreciation reform of any type is capable of standing on its own feet and will probably cost the Treasury little, if anything, in immediate revenue loss.

Further in the long run, liberalized depreciation should and can modernize our industrial plant to a point where costs will decrease and profits will increase and thus the tax base will be broadened so that it is quite possible that tax revenue will increase rather than decrease. This is not just a sanguine assumption, but can be demonstrated by a study of the Canadian experience, as well as an examination of those companies that have installed a considerable amount of modern equipment during the past ten years. A number of these companies were able to improve their earnings as a result of more efficient operations due to modern facilities. The opposite was true of other firms who, because of their inability to invest adequately in plant and facilities, showed either very poor earnings or actual losses at low rates of operation.

Depreciation reform, which hopefully will come in the near future, is needed if we are to maintain a rising trend in productivity, for productivity can only increase through the continual installation of new and better equipment. Further, this new equipment, which will allow our industries to operate more efficiently, is a necessary requisite to help American companies meet foreign competition and save American jobs. ▲

CONCENTRICITY

MORGOIL

for the ultimate in rolling tolerance

New production methods and machining precision make possible a degree of bearing concentricity never before achieved. Extra care and accuracy in every step of manufacture give MORGOILS their ability to hold close rolling tolerances—under high loads and fastest speeds—with unmatched freedom from wear, fatigue and maintenance.

Seen through this 46" diameter Morgoil sleeve is the internal-external grinder specially designed for Morgoil manufacturing precision.

MORGAN WORCESTER

MORGAN CONSTRUCTION CO.

WORCESTER, MASSACHUSETTS

ROLLING MILLS • MORGOIL BEARINGS • WIRE DRAWING MACHINES • COMBUSTION CONTROLS

Retaining Flexibility in the Design of Mechanized Merchant Bar Mills

Mechanization of hand fed mills and further mechanization of semi-mechanized mills are important if these mills are to continue in operation as economical units. However, the mechanization must permit the mill to retain the flexibility necessary to handle a large variety of products.

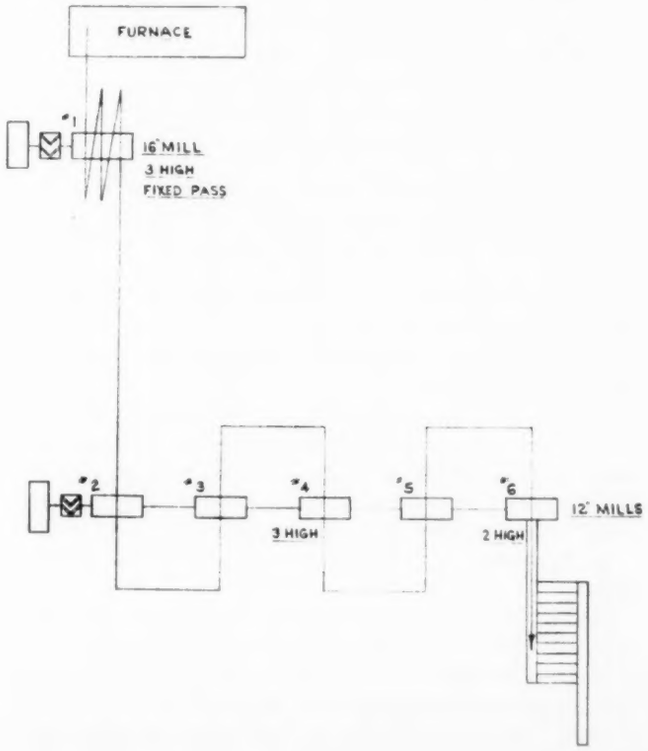
by EDWARD C. PETERSON
Vice President
Rolling Mill Equipment Div.
and WILLIAM H. BOBLITZ
Roll and Mill Machinery Sales Engineer
Birdsboro Corp.
Birdsboro, Pa.

MILL flexibility may be defined as the quality of being able to be changed from one product to another with a minimum of downtime and labor. This quality is relatively important in merchant bar mills, as compared with other types of mills, because:

1. Merchant bar products have a large range of sizes and shapes, requiring many different roll passes for their production.
2. The mill equipment and accessories are complex and require frequent changing or adjustment with the changing product.
3. Orders for merchant bar product are relatively small, so that change-over time can be more important in over-all mill production than is the mill's actual rolling capacity. This factor varies greatly. Mills in large industrial areas get larger orders than mills in smaller areas, while in many foreign countries the orders are even smaller. Mills rolling carbon steel get larger orders than those rolling specialty steels, such as alloy and stainless. Companies with many mills can group orders, while companies with only one merchant bar mill must put all orders on one sales policy with respect to minimum size orders that will be accepted. Interrupting rolling cycles to make a short delivery also has a great effect.

There are three main areas of consideration that

Figure 1 — The Belgian mill is felt to be a very flexible mill arrangement.



affect the flexibility of a bar mill: (1) the mill layout; (2) the design of individual items of mill machinery; and (3) the roll pass design.

Mill layout, which covers the arrangement of the stands and auxiliary equipment will be examined first. The Belgian mill as shown in Figure 1 has been considered to be the most flexible arrangement. In this mill there are five stands in train with a rougher of larger size ahead. The reasons for its flexibility are many:

1. It is generally hand served throughout.
2. There are multiple passes in each stand, except the finisher, so passes can be dropped out readily to furnish varying stock for different sizes.
3. In the event of a complete roll change, this mill will have the fewest number of sets to change.
4. The roll designer can work with any sequence and type of passes that suit his circumstances. For instance, in rolling flats edging passes can be taken at any point desired.
5. The bars may be looped for small sections or run out for heavy sections.
6. By placing portable crop shears around the mill area, cropping may be done at any point to suit rolling conditions.
7. The roller can readily check the bar section after any pass.

Besides flexibility, this mill has other pertinent characteristics:

1. The compact arrangement of the mill minimizes space requirements.
2. It has the lowest capital cost of any mill which can do a comparable amount of work.
3. Rolling speeds and production are necessarily low, limited by the ability of men to serve the first stands of the finishing train with heavy sections.
4. The numerous loops and the slow rate of rolling of the finishing train limit the weight of billet that can be rolled into a finished bar with good tolerance.
5. The arrangement of the mill does not lend itself well to mechanization. Mills of this type usually have a very large labor force.

The mill arrangement which is the least flexible of any is the straight continuous mill as shown in Figure 2. The reasons which make this arrangement inflexible are:

1. Speed control is very critical, making the startup of a new section difficult.
2. Any change in section requires realinement of stands and troughs.
3. It is difficult to drop out passes to vary the stock because of the necessity of removing stands in order to dummy through. In addition the speed range limits of the various mill motors usually make it impossible to drop out as many stands as the operator would like.
4. A change of the entire mill involves many sets of rolls.
5. Twisting is not desirable in these mills because of the additional rolling problems it presents. Loop control of a twisted bar is quite awkward; furthermore, quality is sometimes adversely affected by the twisting action. This type of mill is now usually provided with a

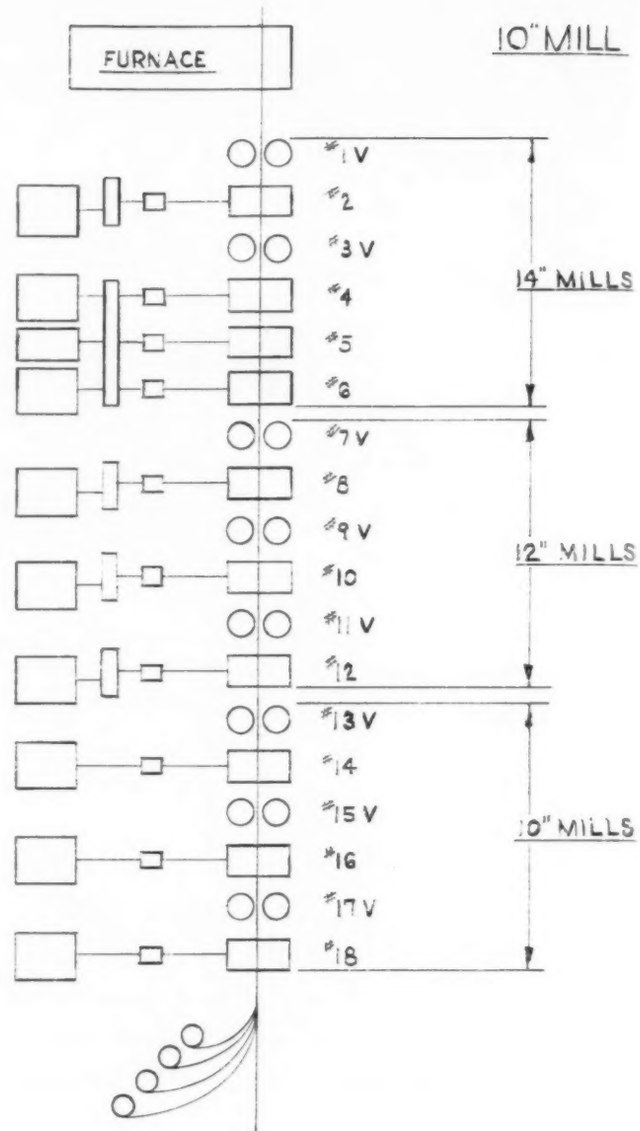


Figure 2 — The straight continuous mill is least flexible and requires careful speed regulation.

number of vertical stands. However, unless some stands are convertible from vertical to horizontal, no given arrangement will suit the desired pass sequence for all types of bar mill products; for example, the rolling of flats will call for vertical stands at the same points where the rolling of rounds calls for horizontal stands.

6. Running out of the bar is impossible and the mill is generally limited, therefore, to shapes that can be side looped, at least between the finishing passes.
7. The bar must be cropped on the fly; therefore, a relatively expensive flying shear must be provided. Because of the expense of such equipment, and the additional space required in the mill line, mills of this type are generally provided with only one crop shear, and all cropping must be done there whether that location is the best place for any specific section or not.

8. Except for the use of test bits, it is impossible for the roller to check the section of the bar during the rolling process, other than by holding a stick on it and observing it as best he can. This makes the correction of section and the location and elimination of defect-producing conditions very difficult.

Other pertinent features of the straight continuous mill not concerned with flexibility are:

1. The space requirements are intermediate. The mill can fit into a very narrow bay and the continuous arrangement of the stands keeps the length from getting too long.

2. The mechanical cost is very high. There is one mill stand for each pass of the largest number of passes to be taken. Because of the varying sequence of working different sections during rolling, some new mills of this type have two more stands than are ever used at one time. Vertical mills are relatively expensive, costing about 1.5 times the cost of a horizontal mill. Convertible mills cost about two times the cost of a horizontal mill. Most expensive of all is the motor drive, which may include a separate d-c motor for each stand, together with the elaborate control required to make close speed regulation possible, and to minimize impact speed drop.

3. The straight-away arrangement permits high finishing speeds and high production rates.

4. The fast-rolling rates and short time between passes permit the rolling of heavy billets into finished bars.

5. There is no labor directly on the mill. The labor cost is limited to speed, furnace, cooling bed and shear operators, and it is relatively low.

Offering a compromise between the flexibility and low cost of the Belgian mill and the inflexibility and high cost of the straight continuous mill, a number of open-type mechanized mills have been constructed, intended to retain the flexible features of the former and still gain the high production and low labor costs of the latter.

The following are some typical layouts:

Figure 3 shows a Belgian mill layout which has been mechanized by the addition of a tilting table on the rougher and runout tables and transfers on the 4-stand finishing mill. These mechanical features eliminated a number of men and made possible the use of longer billets.

Figure 4 is a mill with two roughing stands designed for specialty steels. These stands make it possible to have a large number of roughing passes in the mill at all times so that a large range of sections can be finished without requiring the changing of roughing rolls. These two stands also prevent the rougher from becoming a bottleneck when more than five roughing passes are required, since the passes are divided between two stands. The roughing stands are served by tilting tables, moving sideguards and a cross transfer. The bar mill stands are served by simple floor tables and transfers, but the bars must be turned up and entered manually. The addition of a 5-stand continuous rod mill permits the rolling of $\frac{1}{4}$-in. rod and gives the mill three possible outlets. When large bars are being rolled to the heavy bed, the small bar stands can be changed; when small bars are being rolled to the lighter bed, the rod mill train can be changed. Multiple outlet arrangements

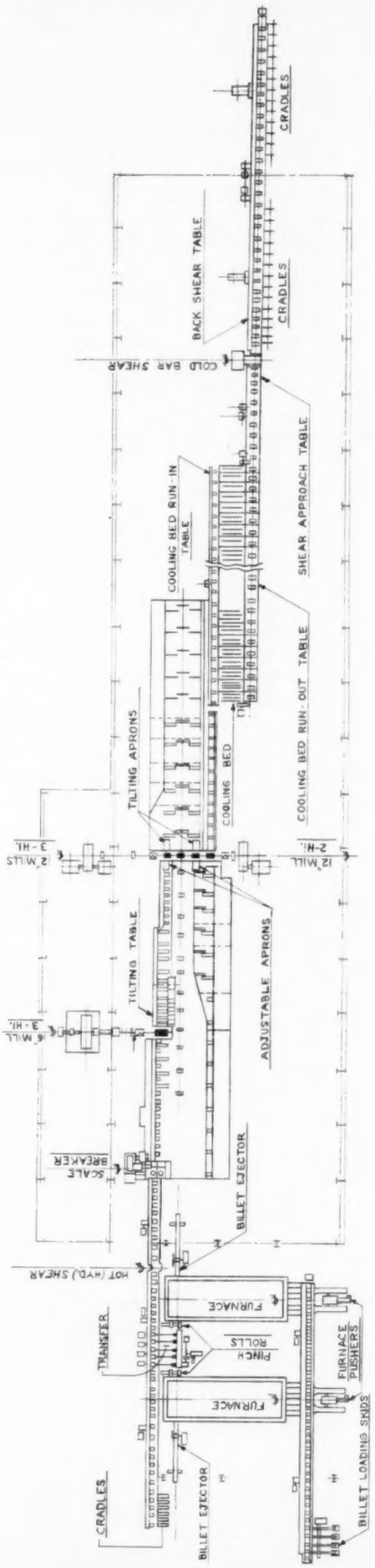
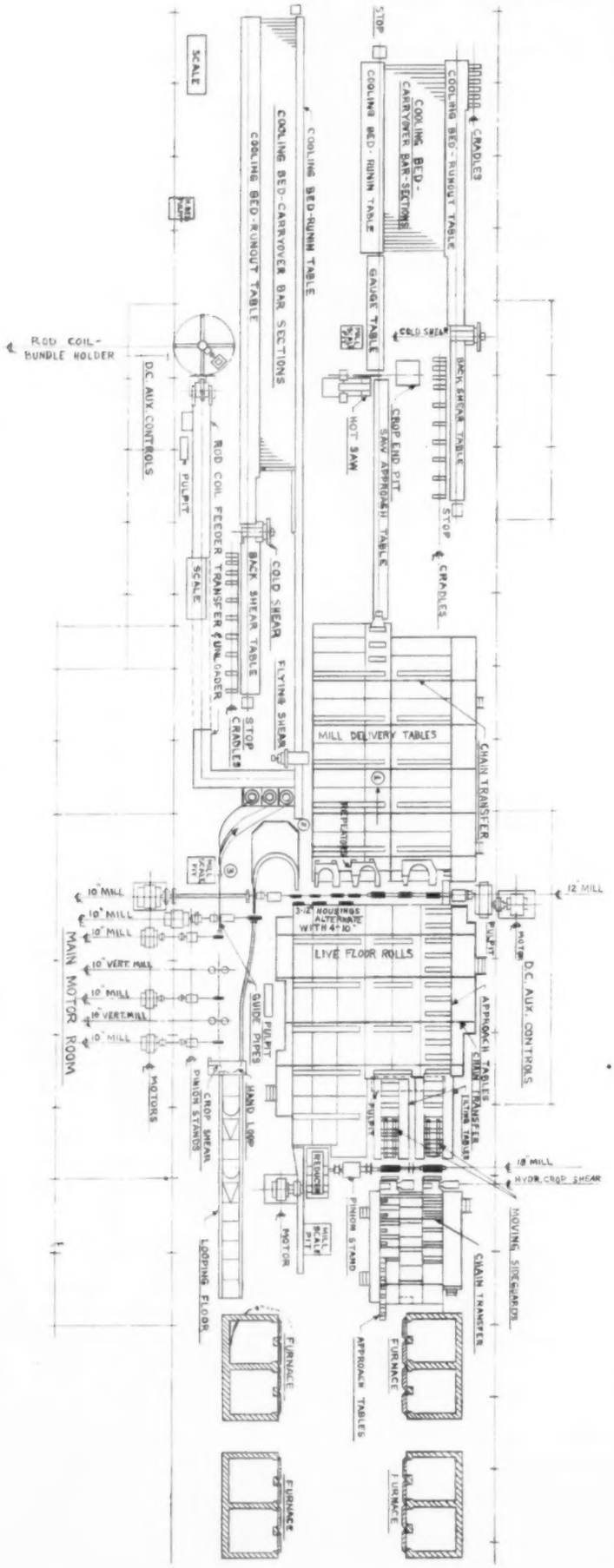


Figure 3 — The Belgian mill can be mechanized by adding tilting tables, to the rougher, and runout tables.

Figure 4 — The use of two primary roughers expands the available passes.



are very effective in a jobbing mill, as they minimize downtime for roll changing.

Figure 5 shows a mill with a reversing rougher also designed for specialty steels. The roughing unit is a 20-in. screw-down mill complete with tables, sideguards, finger lift and auxiliary turn-up. It is a relatively expensive unit, justified only by its flexibility and versatility.

Figure 5 also illustrates an application of an intermediate 3-high rougher with motorized top and bottom screwdowns, which minimizes the need for roll changing. The stand is completely mechanized with a tilting table with automatic drag-over on the backside, two bar turners on the front side and a separate nontilting runout table to permit doubling up the first and third passes in the mill.

Figure 6 shows a 4-stand, 3-high bar mill with traveling tilting tables which was revamped to gain more flexibility. One 3-high stand was eliminated, and a 28-in., 2-high reversing rougher and a 20-in., 2-stand finishing mill were added. As an interesting sidelight, the runout table adjacent to the 3-high intermediate mill can be rolled out of position to permit the use of the fourth stand, to gain flexibility during the period of conversion of the mills' roll inventory to the new scheme of rolling.

Figure 7 shows a mill with a 3-high roughing stand. The rougher is arranged for three passes. A tilting table with dragover serves the second pass but the third pass is turned up manually. With a separate runout table the bars can be doubled up in the mill and rapid production maintained, which is necessary since the rougher feeds a 2-strand rod mill as well as the merchant mill. Intermediate roughing stands are in a continuous arrangement, and include a vertical edging mill for rolling skelp. A 3-stand continuous finishing mill is provided for delivery of $\frac{3}{8}$-in. rounds to the bed. These stands are all horizontal and the two 10-in. stands are geared together. The horizontal arrangement was considered necessary in order to handle multiple strands for the rod mill which follows. Modern practice would indicate three stands individually driven with the middle one convertible from horizontal to vertical, to be used in the horizontal position when multiple stranding, and possibly when rolling some sections and flats, and in the vertical position when finishing rounds and edging flats and angles.

Figure 8 shows a mill with a 4-stand tandem rougher. The rougher is followed by six stands in an open staggered arrangement. These stands are used for rolling all of the heavier product of the mill. The bar does not run continuously in any of these stands, and a maximum of freedom in the handling of large sections is maintained. In order to get additional passes to roll smaller sizes, two 10-in. stands are arranged continuously with the last 12-in. stand in a vertical and horizontal arrangement. These products are small enough to loop on drop and side-looping tables and lend themselves to continuous finishing. It should be noted that the flexibility of the mill is not seriously affected by the need for loop control in the continuous finishing mill. In a 3-stand continuous mill the speed of the middle stand is set and left unchanged, and the speed of the first and last stands is regulated to hold the loop. If four or more stands are used continuous, loop control

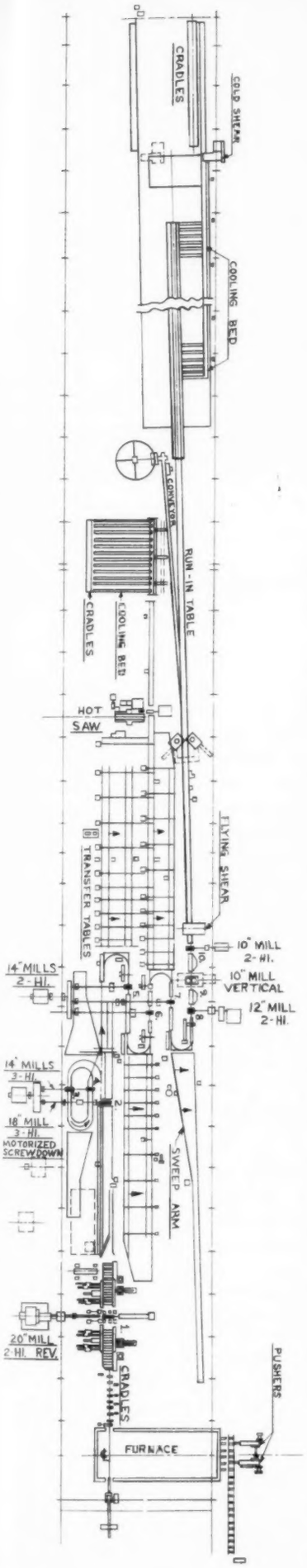


Figure 5 — Use of a 20-in. reversing rougher with screwdowns and auxiliary equipment adds flexibility to the mill.

becomes relatively difficult, since changes in speed to control loop growth must be "chased out" to one end of the mill.

In order to get two additional passes for finishing $^3/_8$-in. round to the bed, looping stands are added at the end of the roughing line. Only one oval and one square are made in these two stands; therefore, the repeating problem is simplified. The finishing mill is completely provided with transfers, bar turners and mechanical escapement repeaters. The transfers are so arranged that the first two stands of the intermediate mill can be by-passed.

The number of passes in tandem and in open arrangement are generally governed by considerations of bar length and building plan. In a mill rolling a wide range of sizes, more than four roughing stands in tandem generally consume too much space longitudinally in the building. On the other hand, mill building width limitations sometimes limit the number of open staggered stands that can be used. Then other less flexible arrangements of rougher, including the use of a 3-high and continuous stands, are required.

Such a mill is illustrated in Figure 9, where the number of intermediate finishing stands in open, staggered arrangement is limited to four. This mill starts with a relatively short billet ingot; therefore, six passes can be taken in the 4-stand tandem rougher, three of them in the first 3-high stand, without producing excessive lengths. A vertical and horizontal 10-in. stand is added for smaller product. In order to get extra passes for $^3/_8$-in. rod without widening the building a 12-in., 4-stand continuous intermediate mill is provided. This latter mill is by-passed when rolling larger sections.

An interesting layout is shown in Figure 10, where a 6-stand continuous vertical and horizontal mill finishes a relatively few sizes of round bars, after an ingot or bloom has been roughed down in a 2-high reversing rougher. This is really not a very flexible arrangement, but it illustrates the possibility of combining these two types of mills where the large number of passes, and possible variations in ingot or bloom size, make a full continuous layout impractical.

Figure 11 shows a cross country mill. This mill also has four roughing stands in tandem, with the third rougher 3-high, and arranged to handle one or three passes. However, in the cross country arrangement some of the intermediate stands are also in tandem arrangement. Such an arrangement is suitable for a mill rolling a narrow range of large size bars. Where the distance between the intermediate stands is not made excessive by long lengths of small section bar this is a practical arrangement.

Multiple outlet points are very advantageous in a mill which has to produce a wide range of sizes. They permit changing from size to size with a minimum of roll changing, and offer the possibility of setting up finishing stands which are not being used, for the next product to be rolled, without requiring the mill to be shutdown for such changing. In a mechanized mill there are always many adjustments and setups to make of troughs, repeaters, bar burners, twisters, etc., so that setup stands which can be arranged outside the mill and put in place quickly are not the entire answer to mill flexibility. If, on the other hand, an intermediate finishing point in the mill can be used without requiring dummying through the succeeding mills, all of the equipment can be arranged while the mill is rolling. Figure 12 gives a good example of such a mill, which is designed for stainless steel production. The 2-high reversing rougher can be furnished with a billet shear outlet at point (1). Although space has been provided for such an outlet for producing billets, it has not yet been installed on the mill. Thus, without any roll or guide changing whatsoever, the mill can proceed to roll billets from small ingots, or double convert from blooms while the rest of the mill is being setup for any program desired.

The next outlet point is in a 3-high intermediate mill with top and bottom motorized screwdowns, shown at point (2). Large rounds and flats can be finished here and transferred directly to the hot saw and a short heavy cooling bed. A 16-in., 3-high mill at point (3) provides the next finishing point, and this product can be transferred directly to the heavy cooling bed. Two stands in open staggered arrangement provide the next finishing location at point (4),

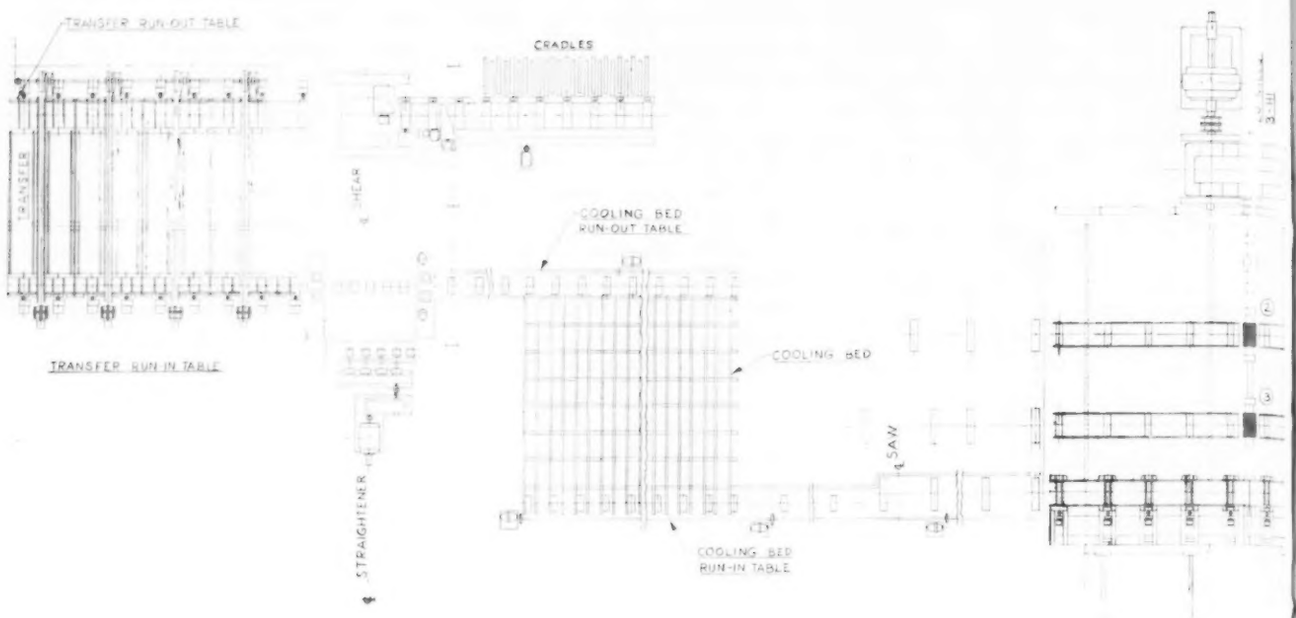


Figure 6 — A 28-in. reversing rougher and a 20-in., 2-stand finishing mill have been installed to increase the mills' production capabilities.

delivery directly to the heavy cooling bed. All of the smaller product delivers from a 12-in. mill shown at point (5) to a long lighter cooling bed. Thus five finishing points are provided in the mill layout, all of which leave the following tables, transfers, and stands free. Additional flexibility is provided by the fact that from three to nine passes can be taken in the 20-in. rougher, one or three passes in the intermediate 18-in. mill, two or no passes in the 16-in. mill and two or no passes in the 14-in. mill while finishing in the 12-in. mill.

The ultimate in flexibility can be obtained by providing several completely separated finishing trains served by a single flexible type of rougher as shown in Figure 13. Here a 20-in. reversing rougher can finish slabs or billets at point (1) and deliver to a hot saw and cradles without interfering with the rest of the mill. It can also break down slabs for delivery to a continuous strip mill for finishing into strip at point (2). The range of larger bar sizes is finished in a 12-in. open staggered mill at point (3), and smaller sizes down to $\frac{3}{8}$ in. can be delivered to the bed at point (4). Sizes down to $\frac{1}{4}$ in. for coiling are delivered at point (5).

Such a mill, of course, represents a sizable capital outlay in finishing equipment, only part of which can be operated at any one time. It is only suitable where relatively limited tonnages of any one kind of product are required, since the great versatility of the mill necessarily limits the amount of any one type of product that it can produce. However, where the ultimate in flexibility is required it is a good investment, and represents a mill which, with proper scheduling, can roll almost continuously. It was designed for the production of specialty steels.

Examining these open mechanized mills, some features as they affect flexibility may be seen:

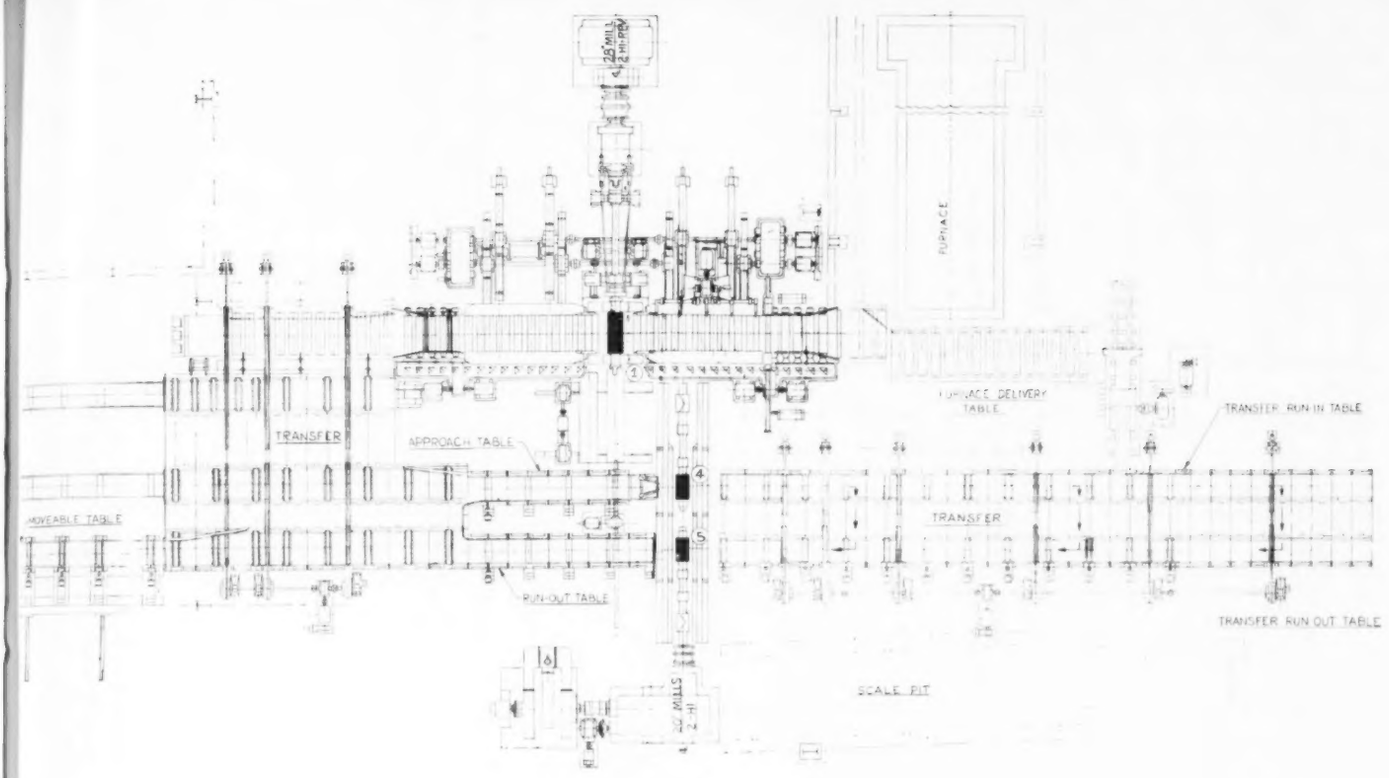
1. The possibility of by-passing stands minimizes roll changing.
2. The open arrangement of the stands permits any arrangement of flat, edging or shaping passes to suit the roll designer.
3. Intermediate and finishing stands, except for the continuous finisher, may be worked by repeating or by stranding at will.
4. Cropping may be done only at points where shears have been installed, but relatively inexpensive stationary shears can be used.
5. The bar section can be checked at all points except if the mill is repeating or continuous finishing.
6. Speed control is not critical.
7. There are many items of mill equipment and accessories to adjust for different sizes.

The flexibility of any layout is dependent on many interrelated factors, and may vary from mill to mill depending on the intended function. Therefore, an exact "flexibility rating" cannot be made for any specific layout. Nevertheless, it may be of interest to make a general and approximate evaluation of the factors which affect the flexibility of various layouts such as those shown above. For this purpose, a numerical rating of various factors as shown in parenthesis will be adopted.

1. Type of furnace: batch (4); continuous (0).

2. Type of rougher: 2-high reversing (12); 2-stand 3-high (7); single-stand 3-high (5); tandem (3); and continuous (0).

3. Type of intermediate mills: 3-high with top and bottom motorized screwdowns (9); 3-high fixed (5); tandem or cross country (3); looping (2); and continuous (0).



4. Number of outlets to bed without dummying: four (10); three (7); two (4); and one (0).

5. Degree of mechanization: none (14); partial (7); and full (0).

6. Type of finishing train: open (8); 3-stand continuous (4); and four or more stands continuous (0).

7. Provision for by-passing number of passes without dummying: twelve (10); ten (9); eight (8); six (7); four (5); two (3); and none (0).

8. Provision for dropping finishing passes without dummying: eight (8); six (7); four (5); two (3); and none (0).

9. Provision for dummying roughers and finishers: four (2); two (1); and none (0).

The above values may be used to evaluate the various layouts shown previously. This evaluation is given in Table I.

It must be emphasized that the ratings are for flexibility only, and that there are many other considerations that suit a mill for a specific application.

The four mills that are rated higher than the Belgian mill have so many flexible features in their extensive layouts that they overcome the disadvantage of being highly mechanized. Some other features of these types of mills may be generalized as follows:

1. They have the highest mechanical cost.

2. The electrical cost because of the possibility of combining drives is intermediate.

3. The production rate can approach those of straight continuous mills on small sizes; because of limitations of repeating speeds the rate will not be quite as high as that of continuous mills.

4. The billet and coil weight are generally somewhat limited, by the arrangement of the stands, to an intermediate figure.

5. Depending on the degree of mechanization and automation, the labor cost can vary from intermediate to lowest.

6. This type of mill probably takes up more space than any other.

It may be interesting to look at some of the typical layouts of bar mills in the western sections of the AISE. Most of these fall in the category of the simple Belgian mill. A simple 10-in., 5-stand mill in the San Francisco district is shown in Figure 14. Here even the separate rougher is omitted and the billet is entered directly into the pony rougher.

Figure 15 shows a mill in the northwest with a 4-stand, 10-in. finishing mill and a 16-in. rougher ahead. Figure 1 showed the standard Belgian arrangement with a 5-stand finishing mill and separate rougher which is illustrative of three 12-in. mills in the San Francisco district and two in the Los Angeles district. These mills have varying degrees of mechanization, some having a few repeaters, others having floor tables and transfers, and some having a degree of mechanization on the rougher. None are completely mechanized, however.

There are five mills in the district illustrative of the continuous arrangement. Two of these mills in the Los Angeles area are arranged substantially as shown in Figure 16 and consist of relatively small stands with grouped a-c drives. They are intended primarily for the production of reinforcing bar. One other unit of similar construction, but with a 3-high rougher ahead is located in the southeastern area of the district.

Figure 17 shows a mill in the Los Angeles district which is primarily a rod mill, and has a typical rod mill continuous roughing train. However, the mill has two open stands for looping into the rod mill finishing train and these two stands are also used for repeating small bar products on to a cooling bed. For edging flats and angles the roughing train is provided with three vertical edgers.

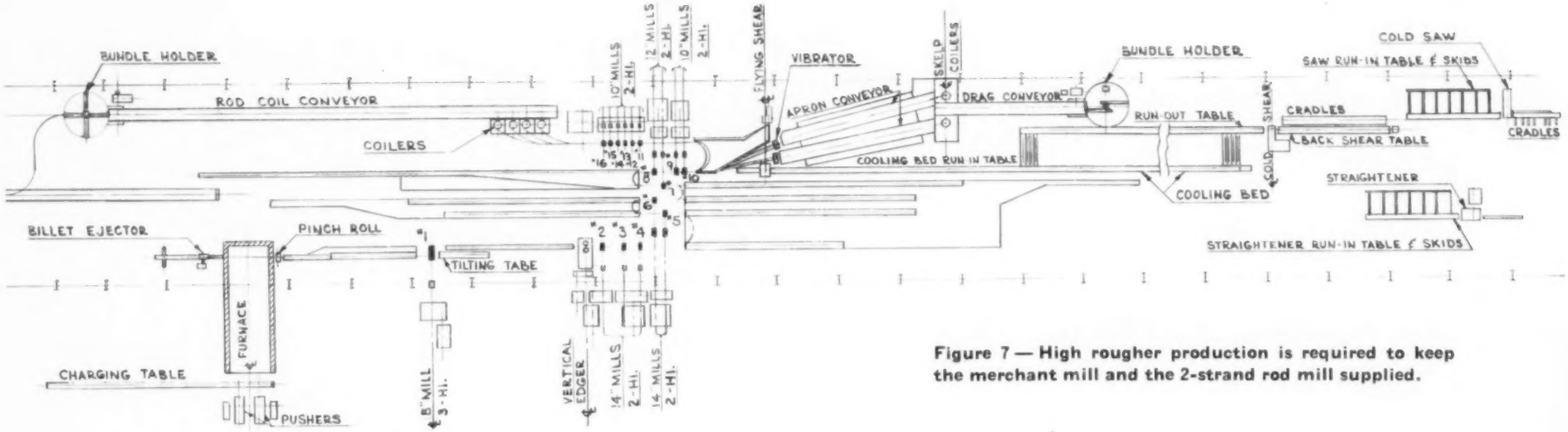


Figure 7 — High rougher production is required to keep the merchant mill and the 2-strand rod mill supplied.

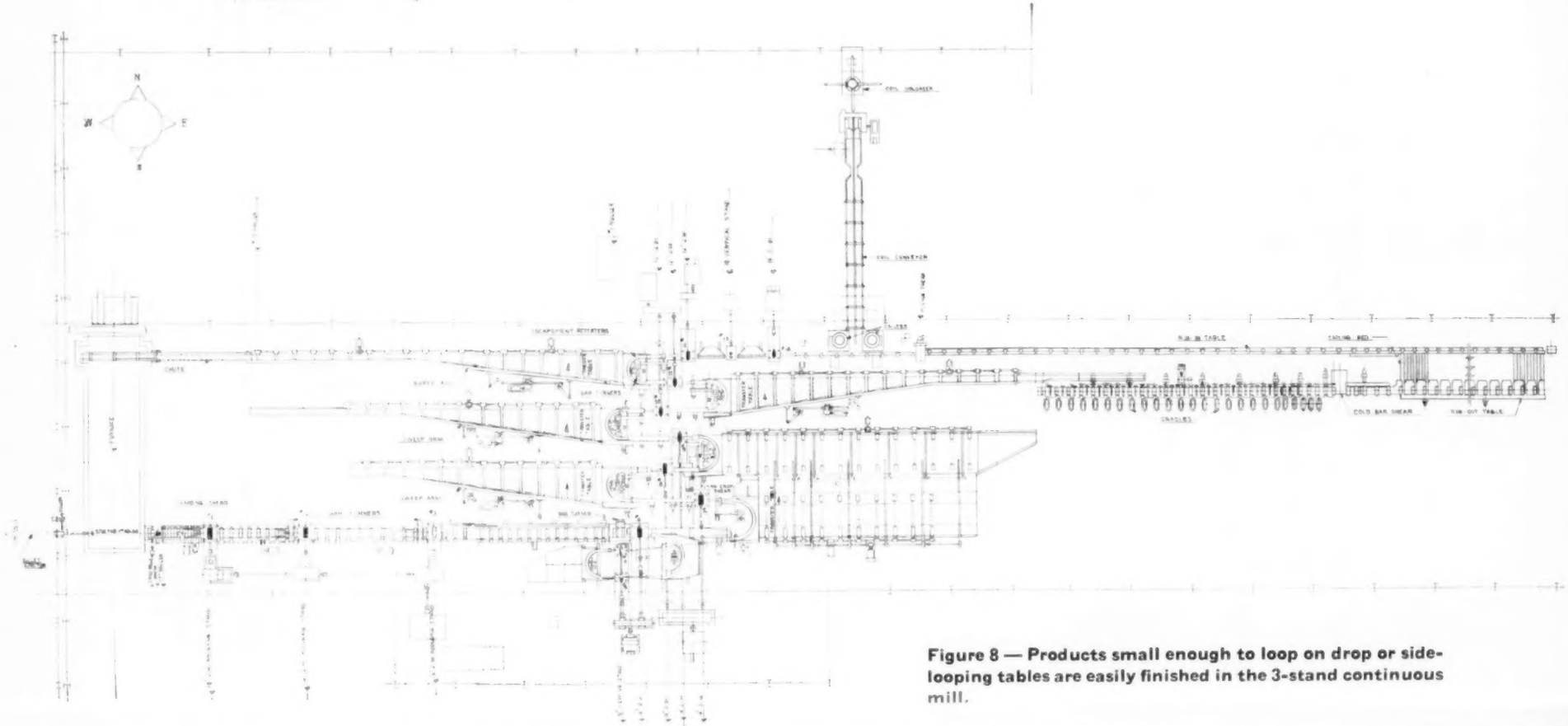


Figure 8 — Products small enough to loop on drop or side-looping tables are easily finished in the 3-stand continuous mill.

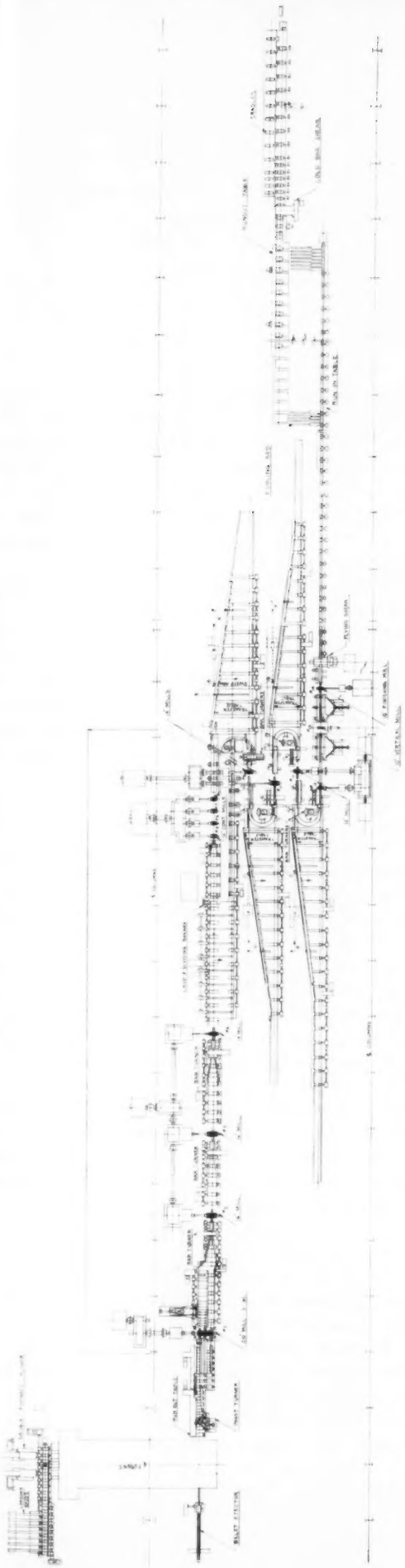


Figure 9 — Width considerations can limit the open staggered arrangement to less than normally desired.

Figure 18 shows a similar mill in the eastern part of the district, which was built as a rod mill and to which a cooling bed has been added, as shown, for finishing bars out of the looping stands.

The open mechanized type of mill is represented by four in the district. Figure 7 illustrated a new one in the northwest. Figure 19 shows one in the Los Angeles district which is completely mechanized. Figure 20 shows a specialized type of mill with a rail slitter which also rolls billet ingots. While the 14-in. head and flange finishing mills, and the 17-in. rougher are not fully mechanized, the 12-in. web finishing mill is, which possibly entitles it to consideration in this class. Mechanical escapement repeaters are being added to the 14-in. mills, which will eventually mechanize those units to a large extent.

Figure 21 shows a partially mechanized mill in the northwest. The layout is basically Belgian, but there are two 20-in. roughing stands which are mechanized with traveling tilting tables. After the 5-stand finishing mill, which again is partially mechanized with tables and repeaters is a 9-in., 2-stand finishing mill.

Figure 22 shows a 14-in. mill, and Figure 23 shows a 10-in. mill, both in the eastern part of the district. These mills have continuous geared roughers, open finishing trains and are partially mechanized.

The requirements for cost reduction which are pressing the steel industry everywhere, combined with the need for flexibility in serving the western market, might indicate the need for more fully mechanized, open type merchant mills in this area in the future.

For the second section of the paper the effect of the design of the mechanical units on mill flexibility will be examined. Considering first furnace equipment, it is suggested that the double row end charge furnace offers the greatest opportunity for heating billets of wide range of length. The billets can be spotted at will before pushing into the furnace and one or two rows can be pushed.

Figure 24 shows a pusher arranged for drive of each ram separately, or both rams coupled together.

Figure 25 shows a furnace discharge parting shear. Such a shear permits the use of full length billets in the furnace at all times. Items which cannot be cut to length on the cooling bed flying shear can be cut at the furnace. This feature improves the furnace efficiency and simplifies providing.

Figure 26 shows a 20-in., 2-high reversing rougher. These units have been applied successfully to mills for the specialty steel trade where production rates are secondary but where quality and flexibility are primary considerations. Since there are no guides or fixed troughs on such a mill, it can roll blooms, slabs and round and square billets into a variety of breakdown squares, ovals, rounds, flats and strip breakdowns without pausing between bars. It is impossible to double up bars in the mill, so if more than five passes are taken, production of the bar mill will suffer. The unit is operated by one man so labor cost is low.

Figure 27 shows an 18-in., 3-high stand with top and bottom motorized screwdowns. This mechanism permits changing the roll opening between passes, and thus various products, and especially flats, can be rolled with fewer grooves than would otherwise be necessary, as will be explained later in the paper. The range of

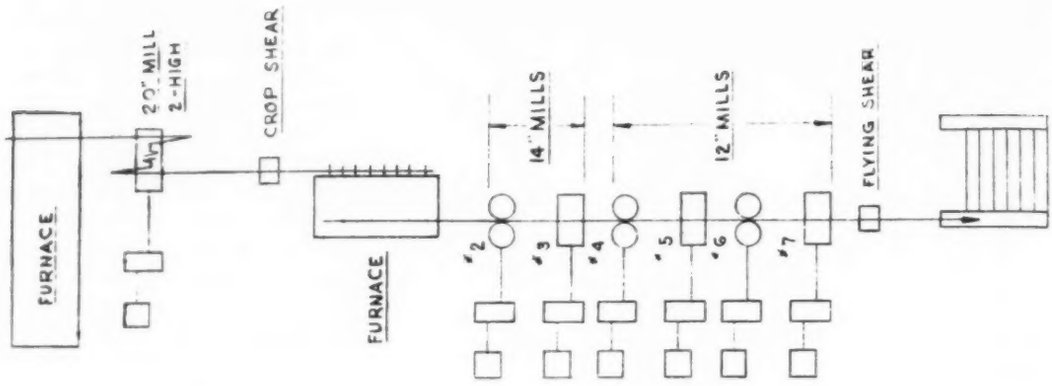


Figure 10 — This layout may sometimes be used where a full continuous layout is impractical.

products that can be produced on one set of rolls is thereby increased. In order to make this adjustment fast and accurate, and since in the mechanized mill only three passes and two settings are required for any one product, a very economical type of preset screw-down control can be applied, using a traveling nut limit switch and a remotely controlled clutch. The limit switch can thus be set from the pulpit and the two operating positions obtained by using the up and down pushbuttons.

Features of roll stands that can improve mill flexibility are:

1. Mill setup stands are ideal since rolls can be changed and guides set and adjusted. Thus a new leader and finishing stand can be put into the mill in a matter of ten or 15 min and rolling started up again.

2. The use of setup stands, of course, requires extra capital outlay for the purchase of additional stands, installation of a crane heavy enough to handle a complete stand, and the provision of stand setup space. Tilting cap housings, as shown in Figure 28, provided with interlocked top and bottom chucks, can make the mill change operation a single lift, thus minimizing roll changing time and not requiring such a heavy crane.

Guide equipment should be designed with a view to facilitate rapid installation and adjustment. Screw adjustments for rest bars facilitate leveling of the guide box. The guide box should be light to make handling easy, and lateral screw adjustments between the rest bar and box are often found useful to permit rapid and accurate line-up of the guides. Also, this box could have a rapid wedge locking device to permit starting up the mill with loose guides and tightening after the mill is going. Extra machining of guides is often justified by the time which can be saved in assembling them accurately into the boxes.

Modern mechanized bar mills are tending to repeat more sections than ever before. Repeating permits the use of bigger billets, minimizes the length of transfer tables required for stranding small sections, and permits faster finishing of the bar with higher finishing temperatures, better gage and less pass wear. In order to repeat sections such as flats and angles which were previously considered to be difficult or impossible to repeat in breakout repeaters, mechanical escapement repeaters are now being used. The adjustment of such repeaters for startup is far less critical than with the breakout type. Modern design permits these units to be left in place in the mill at all times whether repeating or stranding. Figure 29 shows such a unit. The trough of the repeater is lowered for the repeat operation and opens up for loop runout. For stranding operations, the repeater is left in the open position and is shifted laterally by hydraulic means. To serve the mill for stranding, a bar turner, mounted inside the repeater is then in line for entering straight bars, and a separate trough is lined up for bar delivery.

Bar turners, also shown in Figure 29 should have simple screw adjustments to permit handling a variety of sizes without the need for separate inserts. The elevation of the trunnion should be easily adjustable to handle sections of varying widths. The control of repeaters and bar turners can be made automatic by means of photo cells or heat detectors, and should incorporate either mechanical or electrical features for rapid adjustment of timing to varying mill speeds.

Tables and transfers should incorporate some provision for automatically depositing the bar in front of the desired pass. Figure 30 shows a chain transfer with a disappearing dog. The point of disappearance is readily adjustable by a sliding plate under the chain guide which can be set by a socket wrench through a hole in the apron plate. Figure 31 shows a sweep arm transfer whose stroke can be adjusted by relocating a connecting rod in the actuating mechanism. Skew tables are generally undesirable because they do not lend themselves to placement of the bar in the proper position, and because they tend to rotate blunt ovals, making entry into bar turners difficult.

In some mills, especially where alloys are to be rolled and the section requires checking through the mill before starting up a new order, trial bits are often used by the mill crew. In this connection short trough sections immediately ahead of the entry, guides which can be easily removed and replaced are desirable to permit access to the mill by the crew.

Multiple cropping points throughout the mill are often desirable. Flying shears such as shown in Figure 32 are useful for a great many sections. If heavy sections are to be cut, stationary shears, such as shown in Figure 33 are more economical. Open mills reverse the direction of rolling frequently and it is sometimes necessary, therefore, to crop both ends.

When a mill is repeating all passes beyond the rougher, it is difficult for the roller to check the section at intermediate points. Figure 34 shows a type of snap shear which is inexpensive and can be mounted on the face of a mill housing to obtain pieces from the back end of a bar for checking. Such a shear can also be used for

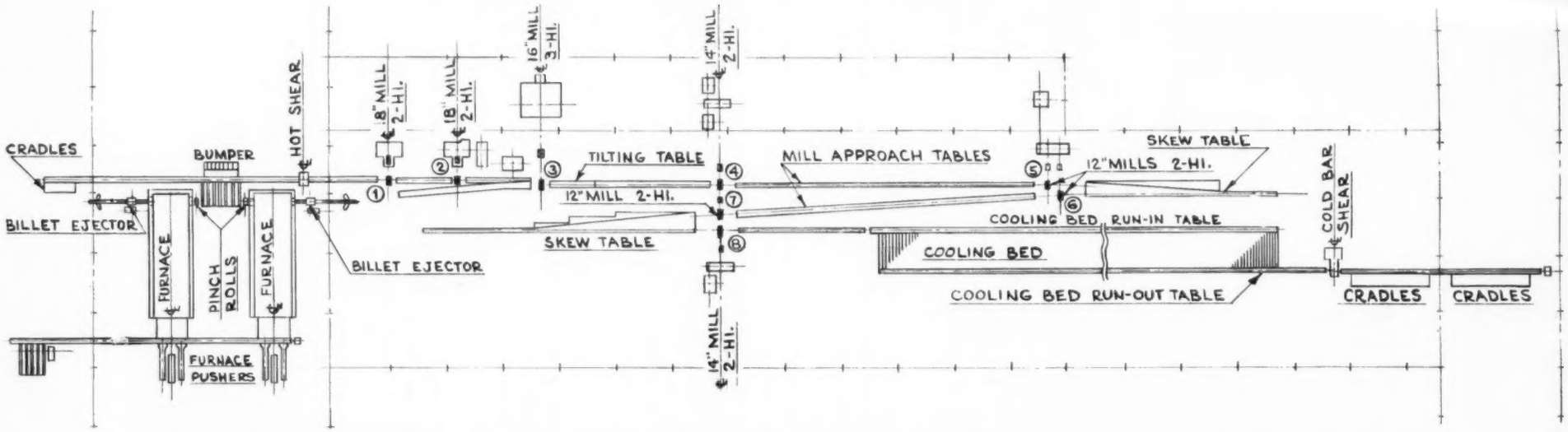


Figure 11 — Tandem arrangements are suitable providing that the distance between intermediate stands is not too great because of bar length.

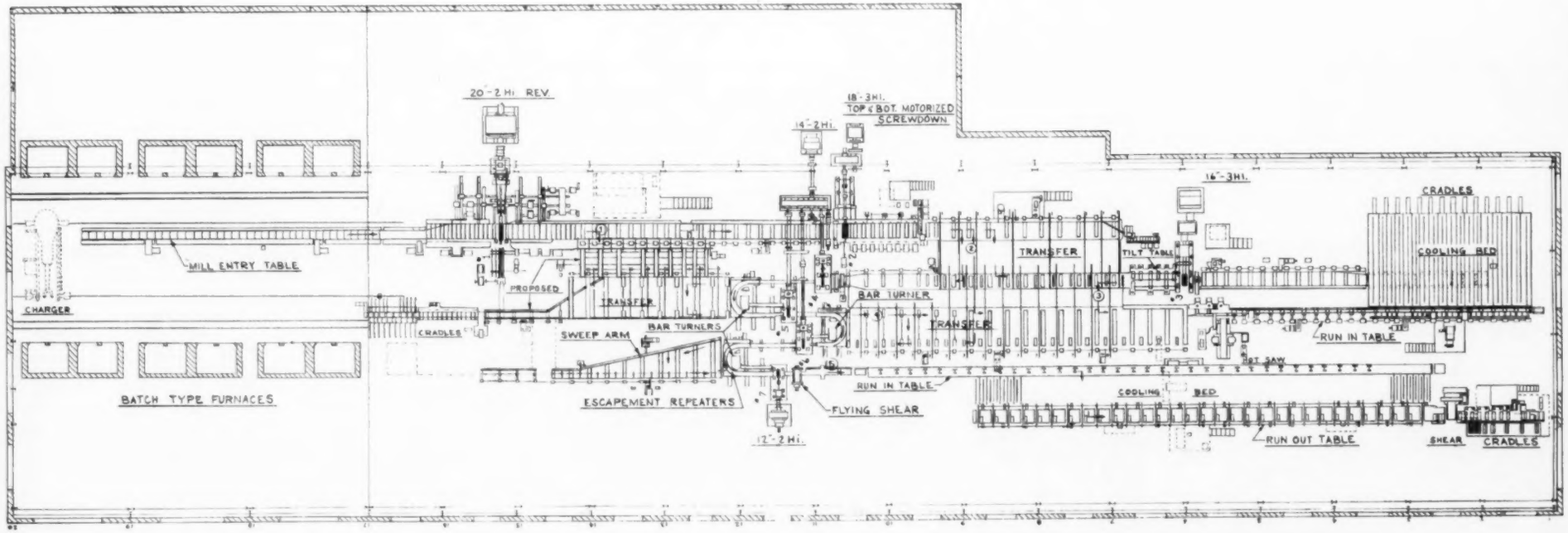


Figure 12 — The use of various mill product outlets permits changing of the following mill setups while the mill is rolling.

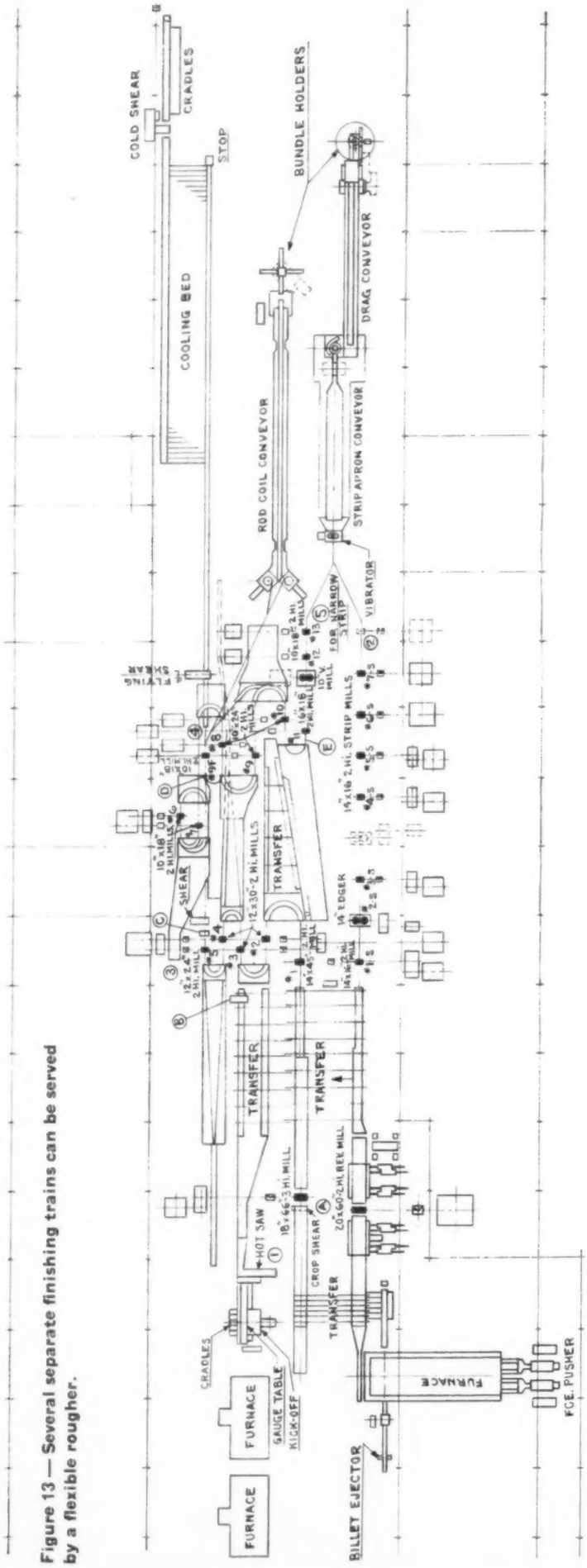


Figure 13 — Several separate finishing trains can be served by a flexible rougher.

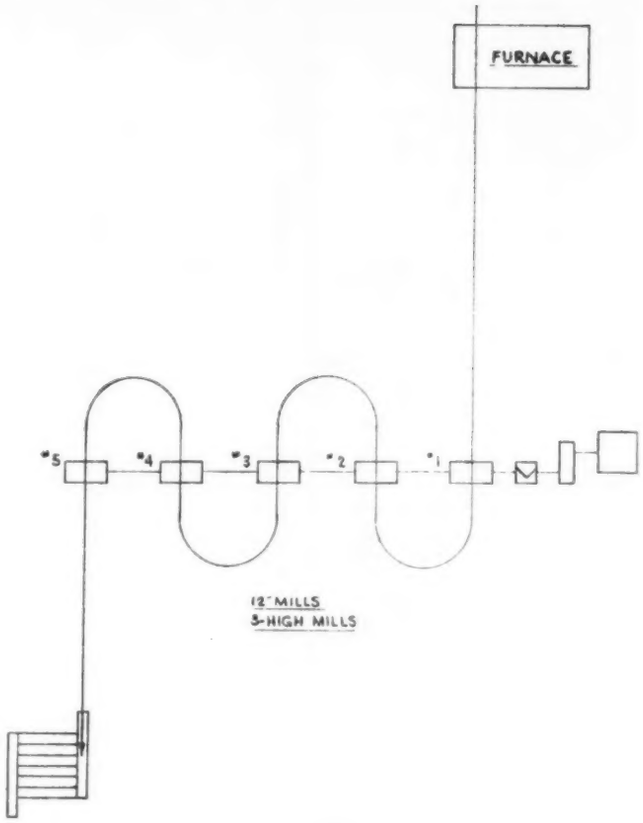


Figure 14 — The use of a separate rougher can be eliminated if necessary.

rear end cropping, and in stranding provides a cropped end for the next entry.

Cropping in alloy mills is extremely critical, being generally required after five passes. In manually served mills, this is taken care of by a portable alligator shear such as shown in Figure 35, these shears being placed at points where cropping is indicated. In mechanized mills for alloy production, the location of mechanized cropping points must be carefully studied. A typical arrangement was shown in Figure 13. In this mill cropping can be performed at five points: (A) is a hand fed hydraulic alligator shear; (B) is a mechanically fed hydraulic guillotine; (C) is a flying shear; and (D) and (E) are hand fed portable alligator shears.

The development of the high-speed, clutch-operated flying shear of the rotary drum type has made the application of these units to cooling beds relatively inexpensive and satisfactory. These in turn improve flexibility in providing for the mill, since billet lengths need not be carefully tailored to the available cooling bed length. There are some problems, in the use of these shears which, however, hamper flexibility of providing.

1. Very short lengths left over at the end of a billet will cause wrecks on the cooling bed runin table, either by stalling on the table between rolls or causing the cooling bed kick-off to function when the following bar is partially on the runin table. This problem can be minimized by providing a lock-out device to prevent the shear from cutting very short pieces at the end of the bar and permitting them rather to run on to the bed as part of the last bar cut, even though they

TABLE I
Flexibility Layout Rating

Mill	Type of rougher	Type of furnace	Type of intermediate mills	No. of outlets to bed without dummying	Degree of mechanization	Type of finishing mill	Provision for by-passing passes	Provision for dropping finishing passes	Provision for dummying passes	Total flexibility rating
Figure 13	4	12	5	10	7	8	9	5	0	60
Figure 12	4	12	9	10	0	8	9	8	0	60
Figure 4	4	7	5	7	7	8	10	5	0	53
Figure 5	0	12	9	7	0	4	10	8	1	51
Belgian mill	4	5	5	0	14	8	8	0	0	44
Figure 6	0	12	5	4	0	8	8	3	0	40
Figure 3	0	5	5	0	7	8	7	0	0	32
Figure 7	0	5	0	0	7	4	5	0	2	23
Figure 9	0	5	3	0	0	4	7	0	1	20
Figure 10	0	12	0	0	0	0	5	0	2	19
Figure 11	0	3	3	0	0	8	3	0	0	17
Figure 8	0	3	2	0	0	4	5	0	1	15
Straight continuous mill	0	0	0	0	0	0	0	0	2	2

overhang the bed somewhat.

2. Short lengths which are too long to be handled as above can be placed on the bed satisfactorily by kicking off at the entry end of the bed. Of course, this is an unsatisfactory location for these shorts when they are fed to the cold bar shear. This condition can be avoided by sectionalizing the kick-off to the cooling bed in such a manner as to permit running all bars to the cold bar shear end of the bed without interfering with closely following bars.

Mills which must handle a range of products from small rounds to wide flats can improve the efficiency of their available rolling space by the use of an alternate notched or flat bar bed as shown in Figure 36. These bars have both notched or flat surfaces available, either of which can be placed in operating position by either a manually or motor operated pull rod. Wide flats can be handled on the flat bars, so the notch spacing can be kept short and the storage capacity of the bed maximized.

The last portion of this article is intended to show the need for and present examples for designing roll passes

Figure 15 — Belgian mill layouts may be widely varied.

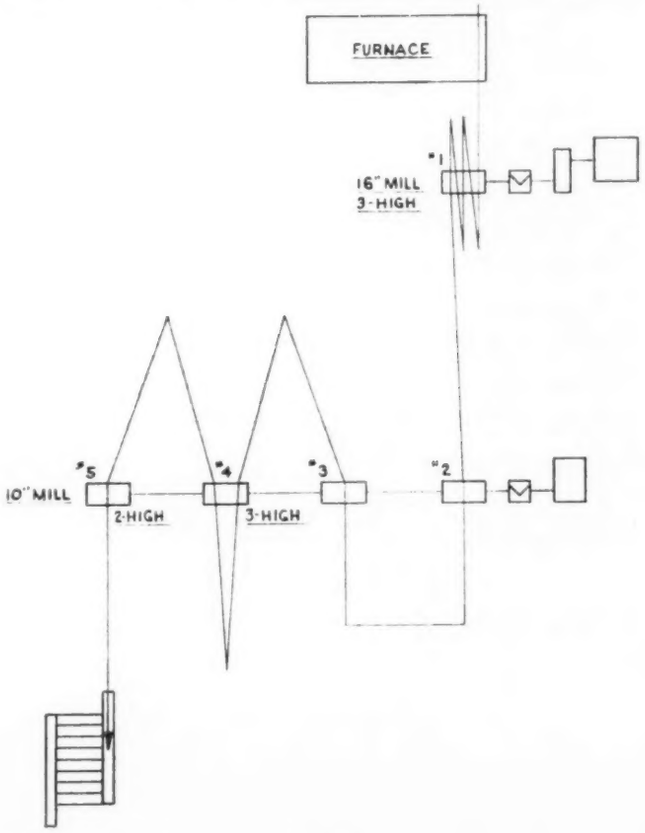
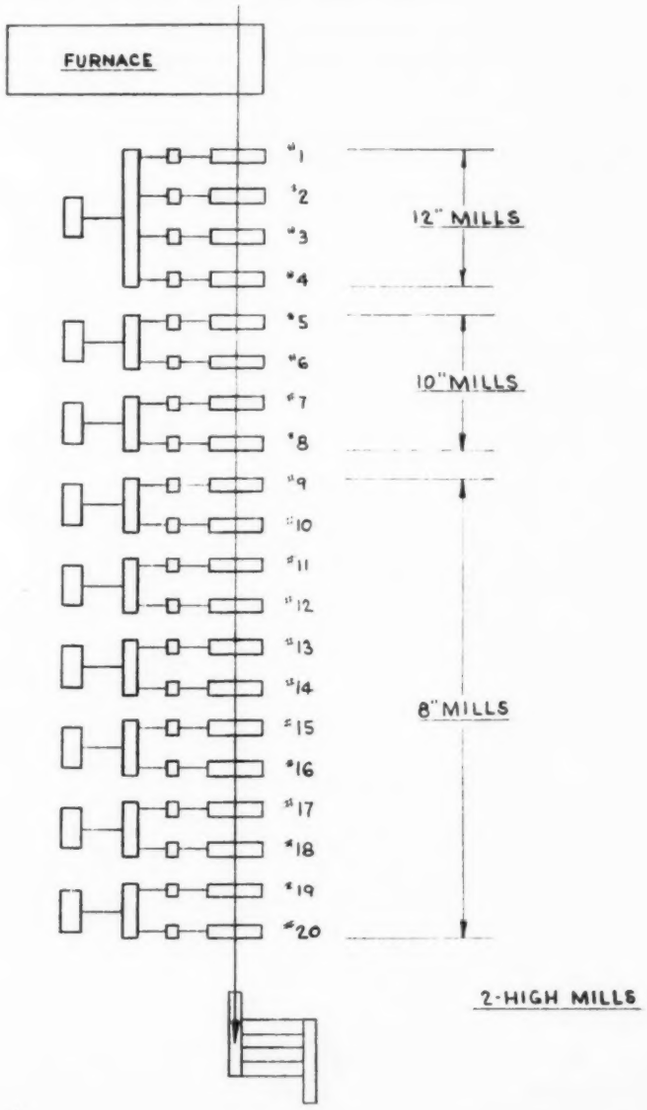


Figure 16 — Several mills using grouped a-c drives were built for production of reinforcing bar.



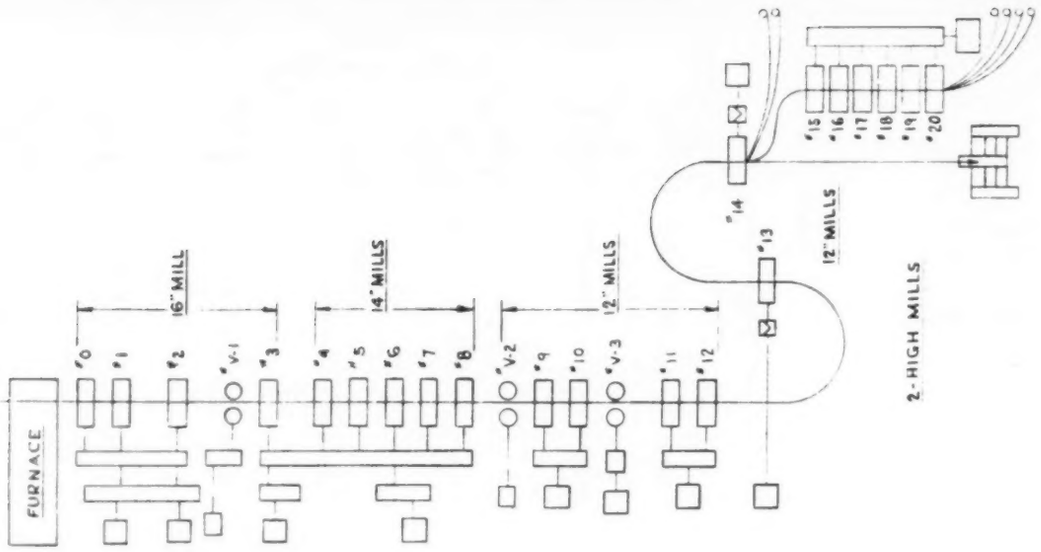


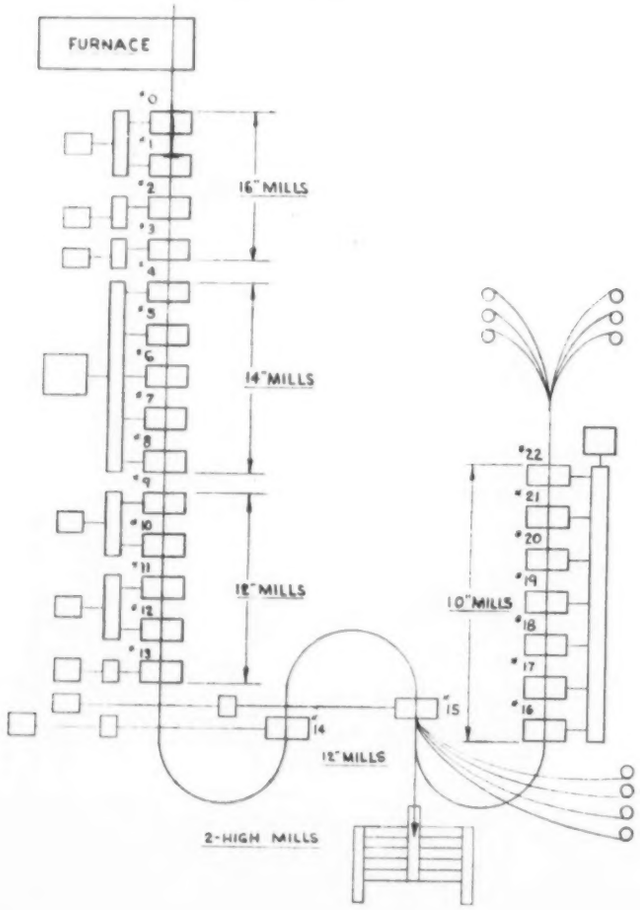
Figure 17 — Vertical edgers are provided for edging angles and flats.

to take advantage of a flexible merchant bar mill layout. To reduce operating downtime the roll pass design must have several features:

1. Roll changing in the roughing unit must be kept to absolute minimum, only for pass wear if possible.

2. Passes in the intermediate stands must be of the type that one pass makes two to four sizes in the following stand, such as one oval making two squares or flatting square on bullhead resulting in various sizes of rectangles to make two to four ovals in the following stands, etc.

Figure 18 — Addition of a cooling bed has permitted finishing bars from the looping stands.

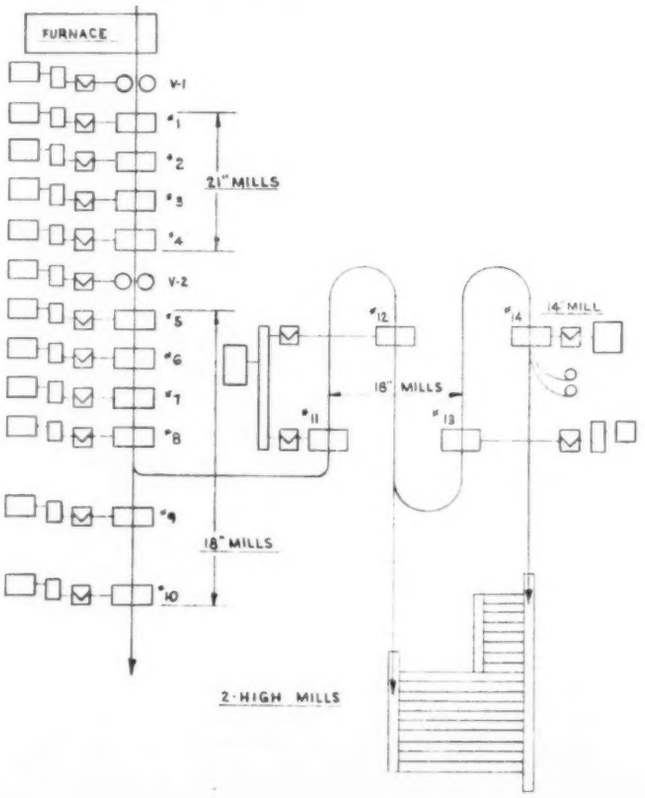


It is much easier to design a flexible roll pass layout while designing a new mill than it is to maintain as high a degree of flexibility when adding new products or increasing the size range on an established mill.

When adding new sections to an established mill the designer is usually faced with scrapping a portion of, or a complete train of rolls, or adding new sets of rolls and passes where necessary. The last is usually the adopted solution, which slowly but surely increases downtime, because the roll pass design has ceased to retain flexibility.

Therefore, it is advantageous for management to look beyond present requirements in order that the roll designer will have more opportunity to maintain a flexible roll pass design. Flexibility of roll pass design

Figure 19 — Complete mechanization can greatly alter the mill operational economics.



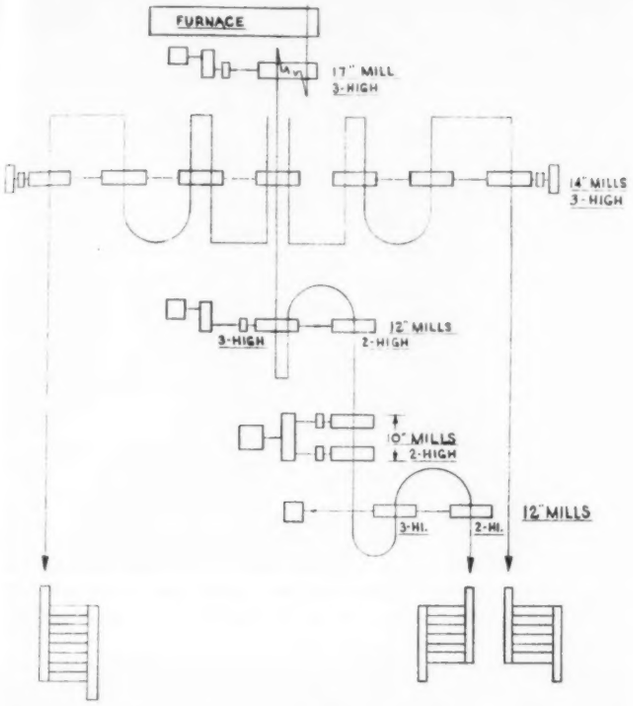


Figure 20 — The rail slitting mill is highly specialized, and it can benefit greatly from mechanization.

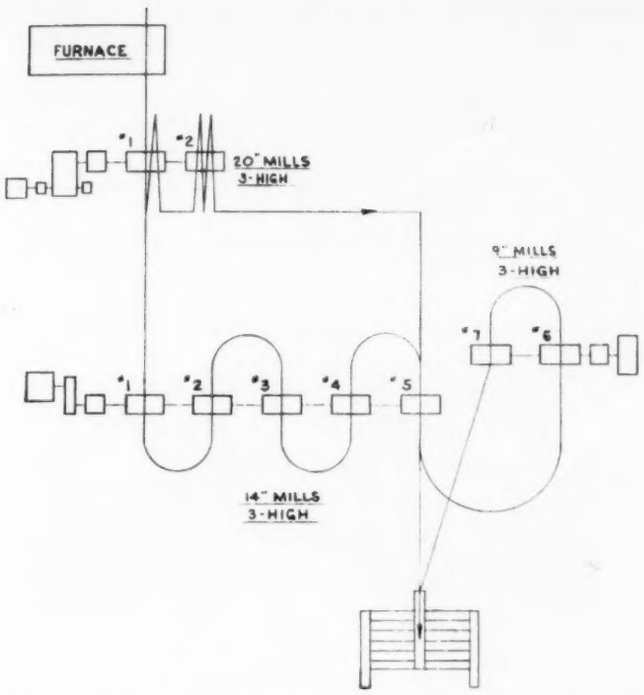


Figure 21 — The Belgian mill layout can be modified to use two roughing stands.

on merchant bar mills starts with: using the least number of billet sizes, and maintaining the least number of grooves in the roughing unit, which is made possible by the adjustment of roll setting in 2-high reversing or 3-high mills with top and bottom motorized screwdowns, etc.

Figure 37 shows a 2-high reversing roll pass design used for reducing a 9-in. square to 6, 5, 4, $3\frac{1}{2}$, $3\frac{1}{8}$ and $2\frac{7}{8}$-in. squares for merchant bar sections, and slabs for narrow strip or skelp up to 10-in. wide. The use of the oval manipulator built in the side guards has been of great help to the roll designer, enabling him to take

Figure 22 — Continuously geared roughing trains are used in many mills.

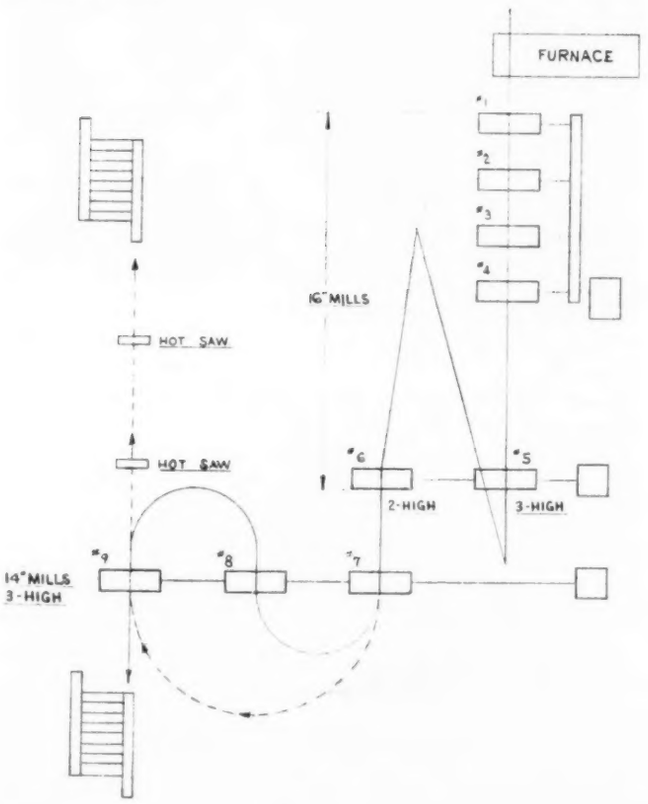
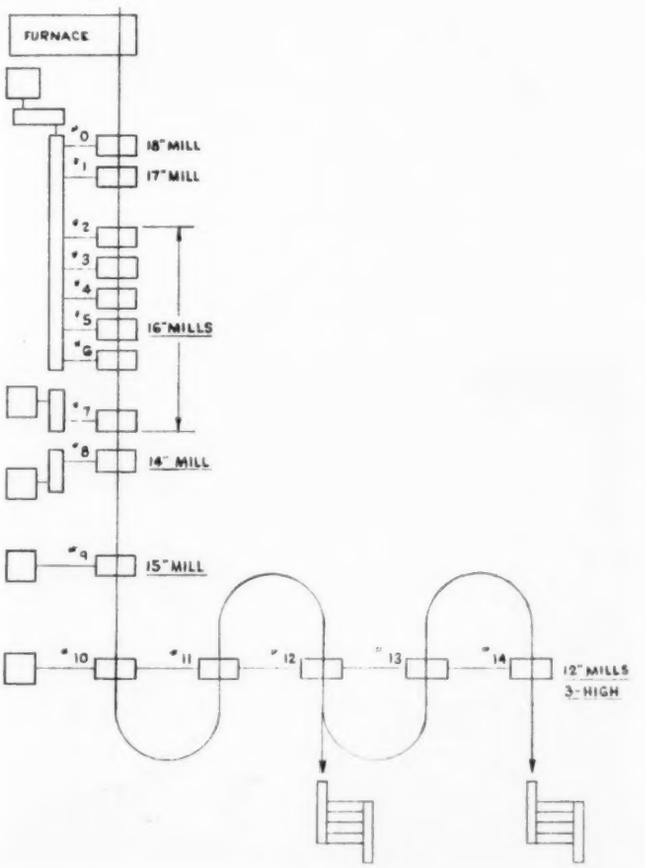


Figure 23 — Open finishing trains normally require a high labor force.



advantage of fast reduction in making small squares on this type of rougher. The 2-high reversing mill offers to the roll designer, by proper use of various roll settings during rolling, the following advantages over the 3-high fixed pass mills and continuous roughing mills.

1. The least number of rolls is required to produce a given range of sizes.

2. The percentage reduction is easily changed. This is especially useful with high alloy or stainless for "babying" tough grades.

3. The bite is greater than in fixed pass mills, due to

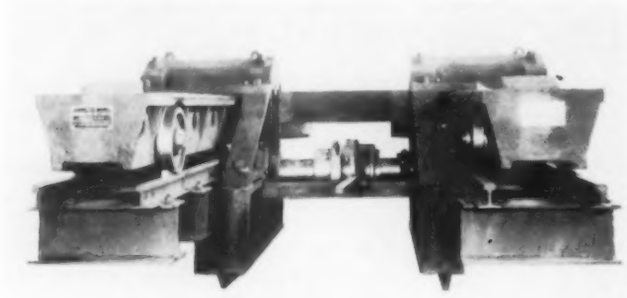


Figure 24 — For charging of a wide range of billet lengths, a double ram pusher is often used.

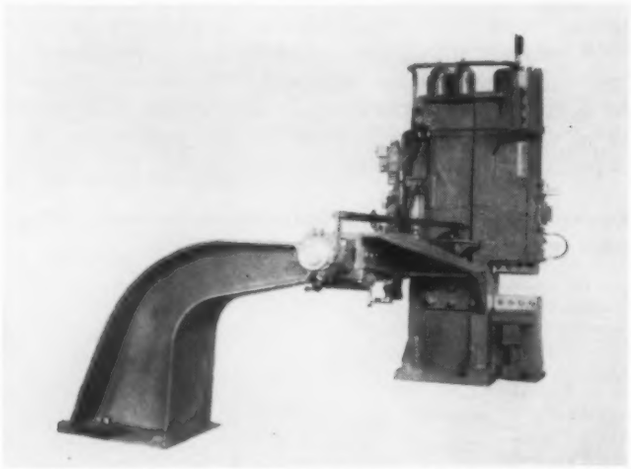
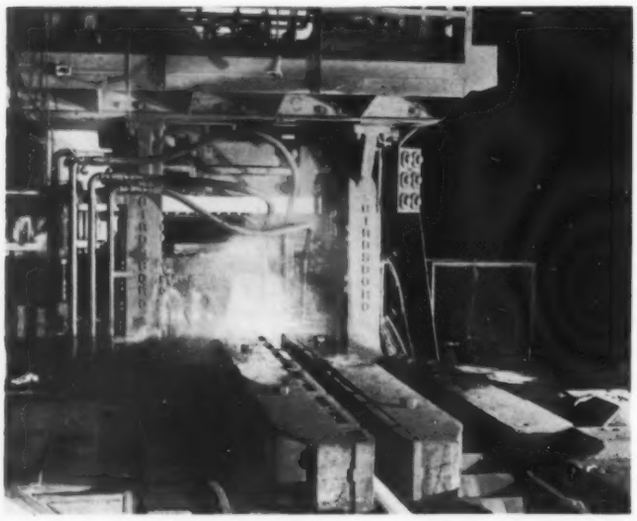


Figure 25 — A furnace parting shear will allow the heating of full length billets in the furnace.

Figure 26 — The 2-high reversing rougher is the most flexible rougher in terms of entering sections which can be handled.



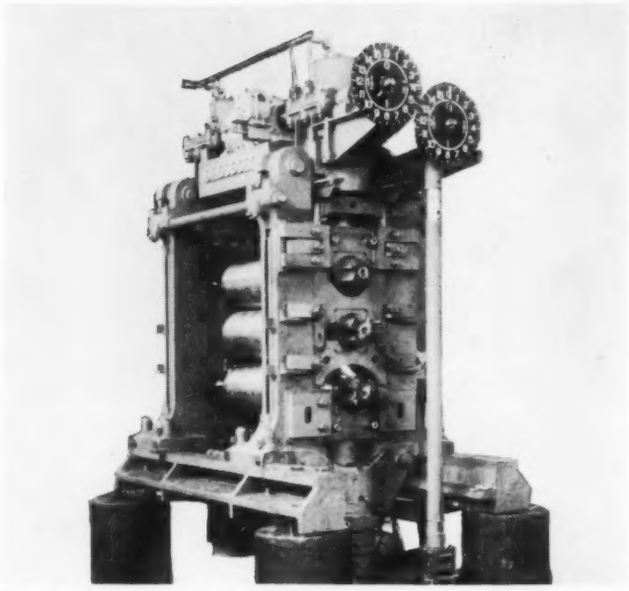


Figure 27 — The 3-high rougher with top and bottom motorized screwdowns can be equipped with an inexpensive preset screw-down control.

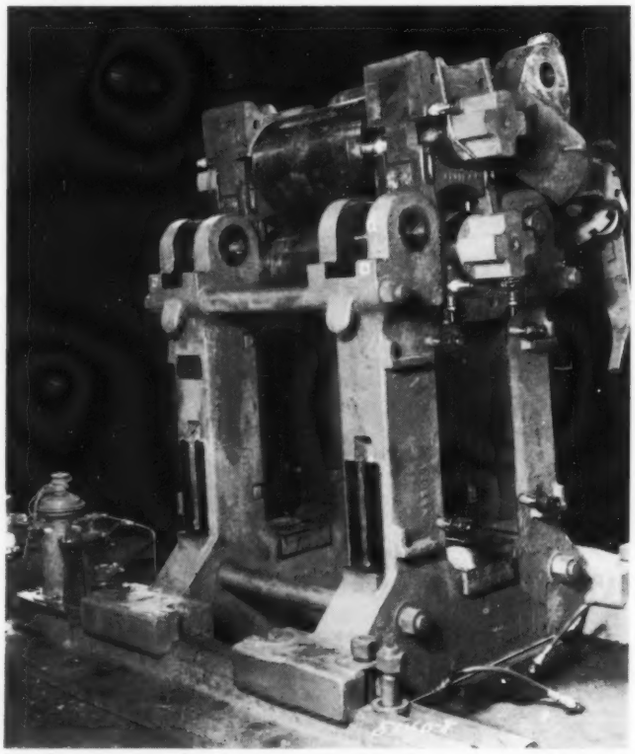
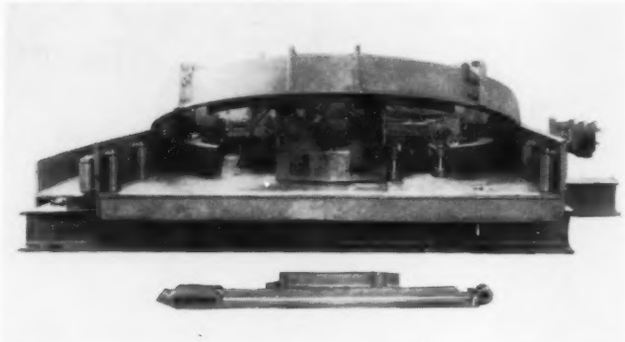


Figure 28 — Tilting cap housings allow more rapid roll changes.

Figure 29 — Mechanized escapement repeaters can be left in the mill while stranding.



shallower passes, allowing larger drafts to be taken.

4. The mill can use a larger billet size than the same size 3-high mill, thus reducing the number of billet sizes required to roll a full range of sizes.

5. No guides are required which eliminates setup time.

Figure 38 shows rolls for a 3-high mill, with motorized top and bottom screwdowns, that is used as a secondary rougher. Used in conjunction with a 2-high reversing mill, it allows the roll designer to secure the stock required in three or five passes, since adjustment for one pass does not affect the other. Larger billets can be rolled to a greater number of sizes for feeding the intermediate stands by this combination of roughers than by any other design of roughing unit.

Figure 39 shows two typical roll pass designs used on a 3-high fixed pass rougher, one using open squares and the other using box pass design. Of the two, open squares offer the most flexibility in that more billet sizes can be entered and more sizes of squares can be produced. Some of its characteristics pertaining to the roll design are:

1. No roll adjustment is possible during rolling.
2. The percentage of reduction is fixed.

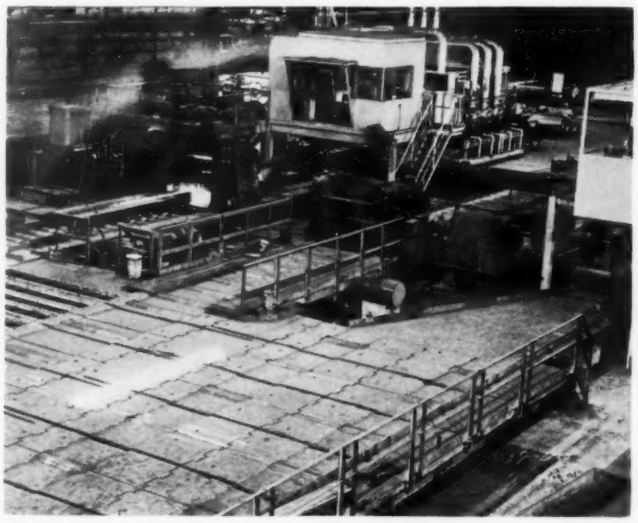
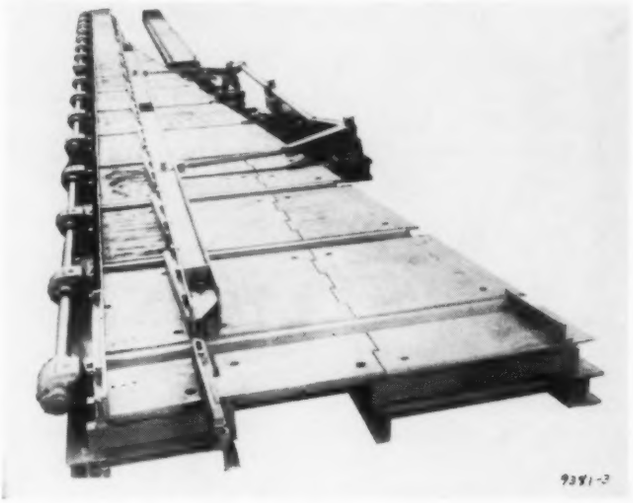


Figure 30 — Chain transfers move the bar to line it up with the proper pass.

Figure 31 — Sweep arm transfers have a readily adjustable stroke.



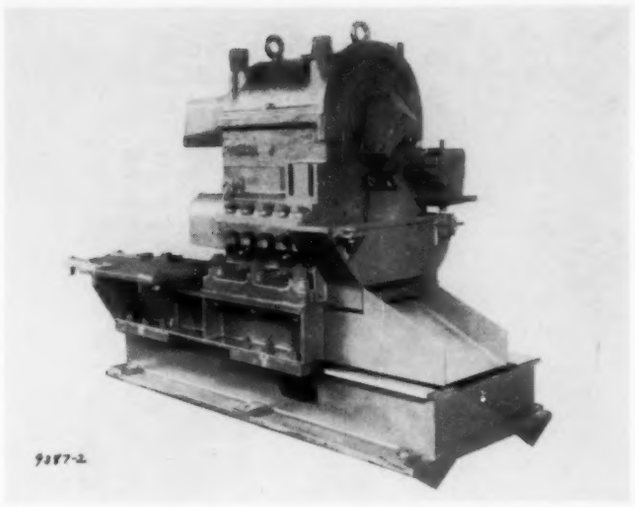


Figure 32 — Flying shears are often used to crop the product as it runs into the cooling bed.

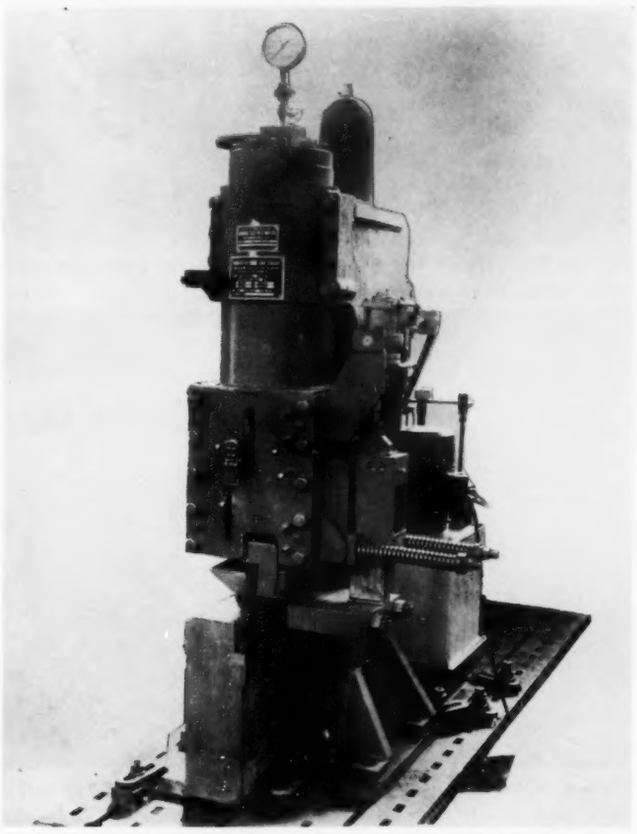
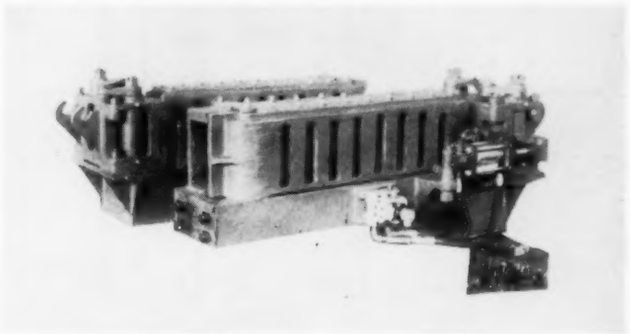


Figure 33 — Stationary shears are more economical when heavy sections must be cut.

Figure 34 — Snap shears can be used to provide a cropped end for the next entry while stranding.



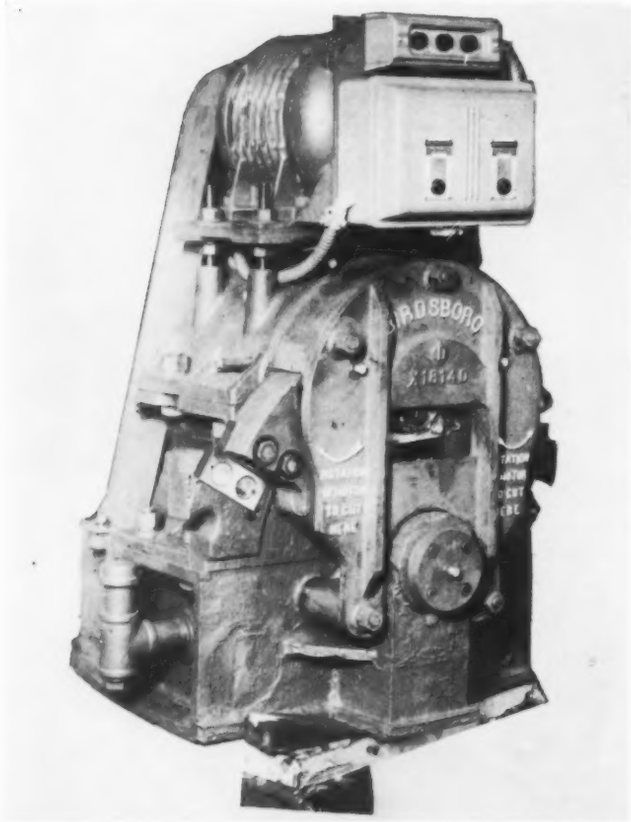
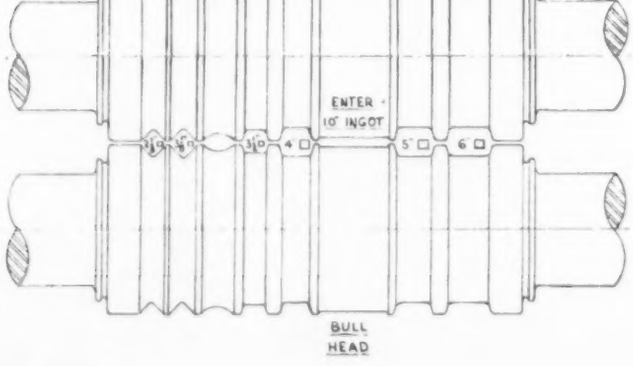


Figure 35 — Hand fed alloy mills of tenuse portable alligator shears for cropping.

Figure 36 — The same cooling bed can be used for wide flats and small rounds with maximum storage capacity for either item.

Figure 37 — The 2-high reversing rougher uses a simple roll pass design to produce a given number of sections.



3. The maximum billet size is fixed.
4. A greater number of grooves is required to produce a given range of sizes than with a motorized screw-down mill.
5. Much time is required for guide setup when changing passes.

A tandem rougher is composed of two or more stands, often four, where the bar runs free between stands. On this type of rougher the roll designer (Figure 40) is free to use the type of pass reduction most suitable to his requirements: flat and edge, oval and square, or diamond and square, and he need not be concerned with the fixed reductions that are required on a geared continuous rougher or with the twisting that is required in an individually driven or geared continuous horizontal rougher.

Flat and edge passes followed by oval and square passes on a 4-stand rougher offers wide flexibility in that one billet size will make several size squares for delivery to the intermediate mill stands. Because the bar runs free between stands, it can be deflected to the side for entry into the next mill more than is possible in close center continuous stands, thereby allowing more freedom in pass arrangement. Other advantages afforded to the roll designer are:

1. Each pass can be freely adjusted without affecting any other pass to suit percentage of reduction required.
2. Larger number of starting billet sizes can be used in the tandem rougher compared to the geared type rougher because the flat and edge method of reduction using a flat pass in No. 1 stand does not require a separate pass for each billet size, as is necessary when percentage of reduction is fixed or passes from one stand to the following stand must be kept in line.

Figure 41 shows rolls for a continuous rougher. This type of rougher is excellent for rod and bar mills of limited size and section range, but it offers the least flexibility for merchant bar mills that are required to produce a much wider range in smaller tonnage lots.

Where each stand is separately driven, the roll designer has more freedom than with the geared type continuous rougher, since he can design for any elongation he should have. This feature is especially desirable when rolling alloys and stainless.

Referring again to a merchant bar mill required to produce a wide range of sections and sizes, the continuous rougher has the following disadvantages compared with the other four types of roughers described.

1. A separate line of grooves is required for each billet size which limits the number of billet sizes that can be used.
2. Excessive downtime is incurred to change lines of passes because of the number of stands that must be set up.
3. Twisting is required.

It is at the start or near the start of the intermediate passes that the roll designer must determine the type of pass sequence he intends to follow, such as oval-square, oval-round, or diamond-square. A number of conditions must be evaluated to make this determination: (1) range of products and sizes; (2) maximum tonnage of each section required; (3) mill layout; and (4) quality requirements.

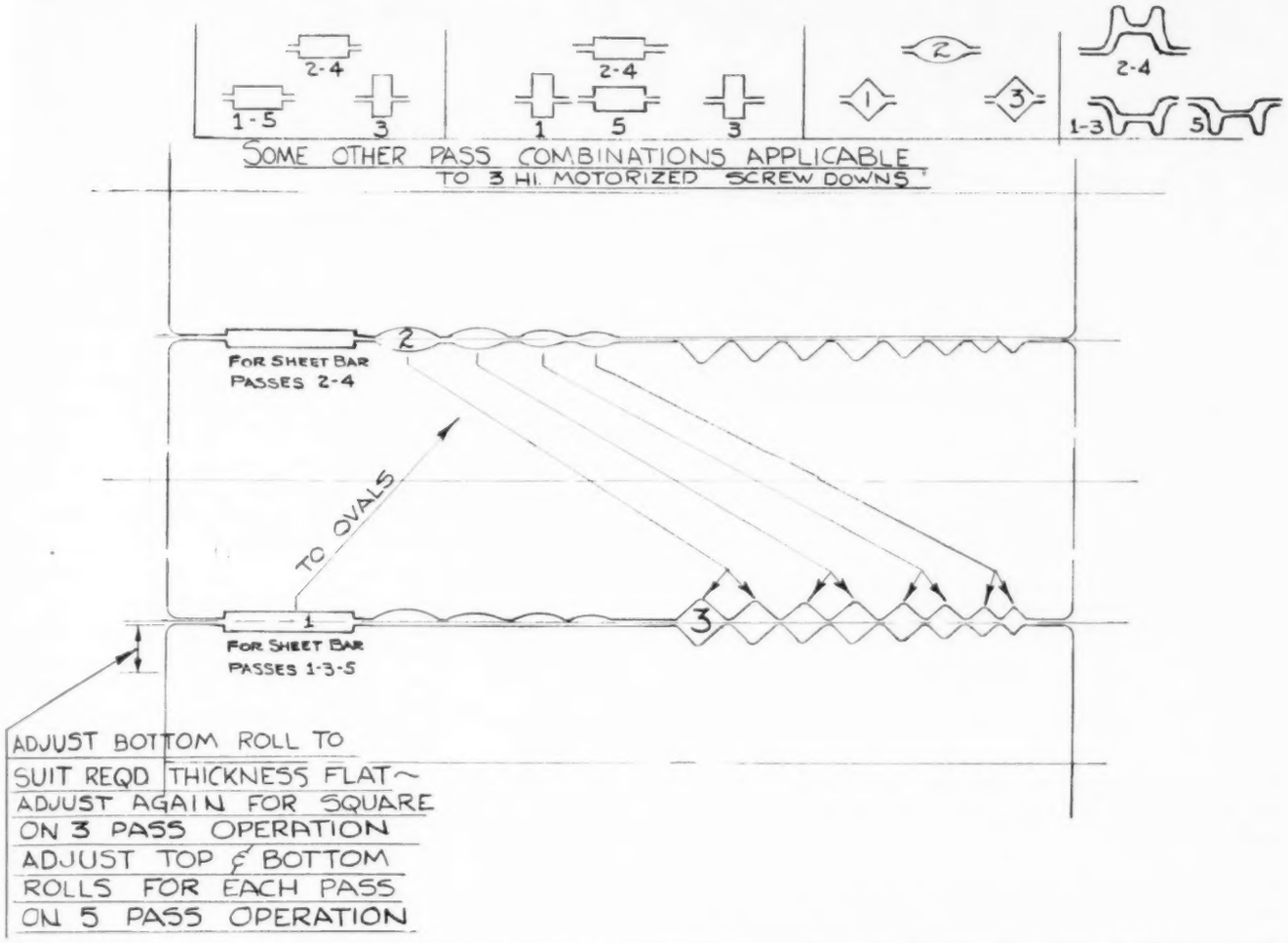


Figure 38 — Use of the 3-high rougher with motorized top and bottom screwdowns in combination with a 2-high reversing rougher offers excellent flexibility.

Much has been written on the three types of pass sequence regarding quality. This article will only compare them with regard to flexibility.

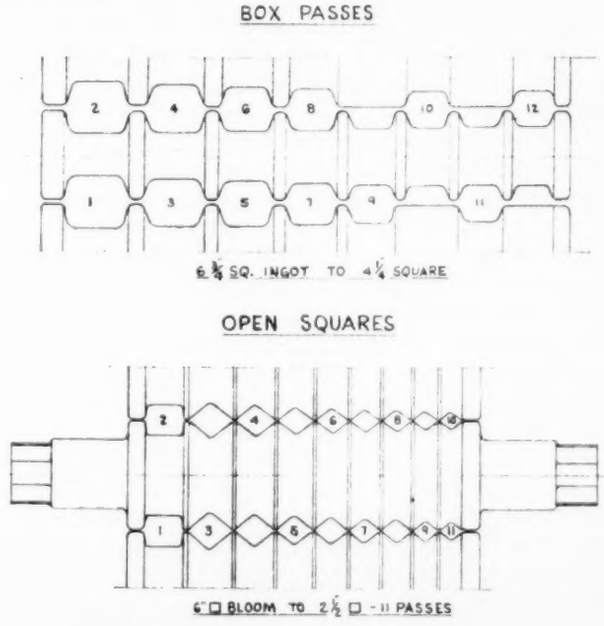
If the maximum percentage of the projected tonnage is in rounds and the mill is straight continuous throughout, or continuous finishing, the roll designer most likely will use the oval-round series as far back from the finishers as is practicable. This offers the most flexibility for rolling rounds because it is possible to drop off pairs of stands to produce larger sizes without changing passes. The oval-round type of pass reduction requires two to four additional stands over the oval-square series to produce a like finished size from the same size starting billet. For example, rolling from a 3-in. square to a $\frac{3}{8}$-in. diameter round would require 16 passes using oval-square and 18 to 20 passes using oval-round series.

On the other hand, if the mill is to roll the full product and size range normally expected of a merchant bar mill, the oval-square series with flat or bullhead passes following a square and preceding a forming pass offer the most flexibility since a flat or square is necessary for entering the first forming passes for angles, channels, flats, large rounds and the leader pass for small rounds and rebar.

This method of reduction allows the designer to use fewer sets of intermediate rolls than would be possible with the oval-round series since neither the oval nor round can be used to enter the forming passes for angles, channels or flats and must be replaced with the oval-square.

The diamond-square method of reduction like the oval-round requires more grooves than the oval-square

Figure 39 — More billet sizes can be produced on a 3-high pass mill using the open square pass design than the box pass design.



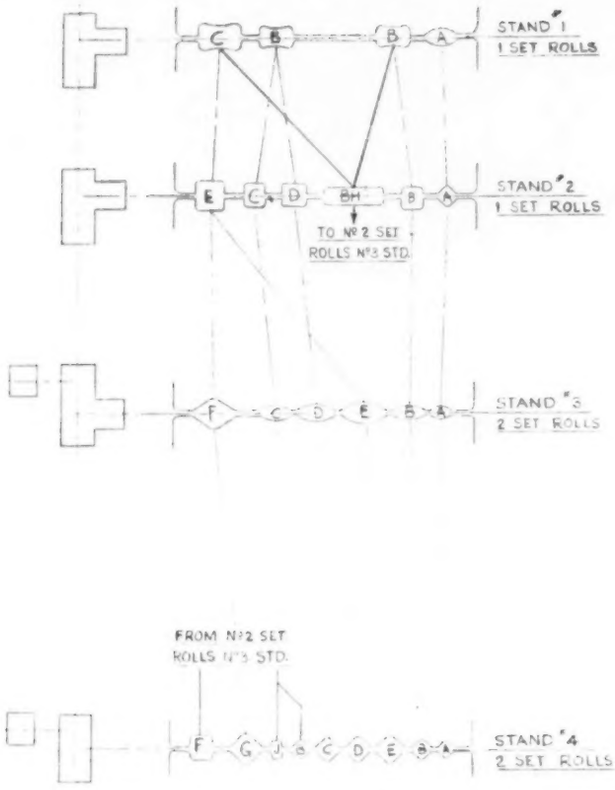


Figure 40 — The free running bar, in a tandem rougher, can be deflected to either side, thus allowing some pass design freedom.

series because the stock from diamond passes cannot be adjusted to make various squares. An additional two passes are required over the oval-square series because of lighter average reductions that must be used.

Four types of mill pass layouts are illustrated to show the method used to insure flexibility in rolling.

Figure 42 is a suggested pass layout for the mill shown in Figure 13.

One set of rolls is used in the 2-high reversing mill for rolling 3 x 9-in. slabs to finish 3 to 10-in. wide x 0.093-in. strip on the continuous strip mill and to break down 5, 4, $3\frac{1}{2}$-in. squares and $3\frac{7}{8}$ and $3\frac{3}{4}$-in. round billets to $2\frac{1}{2}$ to $1\frac{3}{4}$-in. squares or various ovals for entering into the secondary 3-high fixed pass rougher. Also 9 to 14-in. ingots are cogged to 3-in. slabs and billets.

One set of rolls is used in the second rougher. Passes in this stand overlap the 2-high reversing stand, allowing billets to enter either stand. Oval and square and open square reductions are used in the secondary rougher, oval and square to the leader pass for rounds up to 1-in. diameter and guide round forming passes, (that is square-flat-former-oval-round) for sizes above 1-in. diameter and round-oval-round in the 3-stand continuous finishing train for rods. Passes are so arranged in the various stands that the size square necessary to produce various sections and sizes are readily available. Multiple outlets, a sufficient number of roll stands and provision for by-passing stands greatly assist the roll designer, because the size range to be produced from each outlet is much reduced, requiring less roll changes than would have been required with one outlet.

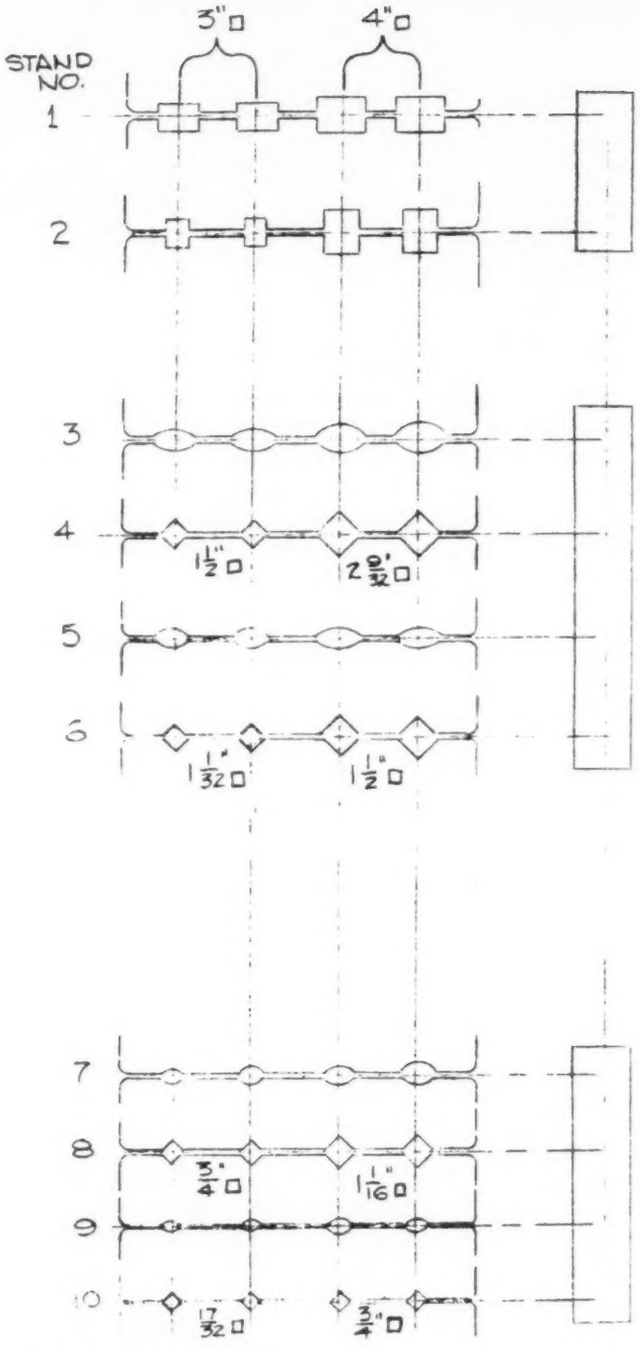


Figure 41 — The continuous rougher requires a separate line of grooves for each billet size.

Figure 43 illustrates a suggested pass layout for the mill shown in Figure 9. Three ingot sizes are used, each receiving three passes in the 3-high rougher in one set of rolls. Box passes are used primarily because of starting with ingots and to prevent free lateral spreading, resulting in cracks. Following the rougher, the product of each different ingot enters a separate line of grooves starting in No. 2 stand with three edging passes. The number of passes start to increase, as the three passes in No. 2 stand make five oval passes in No. 3 stand. The five oval passes in No. 3 stand make six square passes in No. 4 stand. The six passes from No. 4 stand make seven ovals in No. 5 stand and when by-passing stands No. 5, 6, 7 and 8 makes one oval in No. 9 stand, as well as entering two bullhead passes in two separate sets of rolls for No. 9 stand. One bull-

head in No. 9 stand pass makes five former passes for 1½ to 2½-in. rounds in No. 10 stand, while the other bullhead pass makes three squares for smaller rounds and rebar also in No. 10 stand. The oval-square series is mainly used through No. 11 stand with the exception of flat and former for rounds over 1½ diameter finishing on No. 12 stand. The round-oval-round sequence is used for 15/32 to 1½-in. diameter rounds in the 3-stand continuous mill, and 3 to 4-in. wide flats and 1 to 4-in. angles are also included in the products on this mill. Nominal diameter rolls were used throughout the mill with exception of No. 11 and 12 stands where the housings were designed to use 14½-in. maximum pitch diameter rolls for 3½ and 4-in. angles.

Figure 44 shows a suggested pass layout for the mill shown in Figure 12. The 2-high reversing mill receives 4, 6 and 8-in. squares and 10-in. ingots using three sets of rolls. The first set makes 3, 2⅛ and 1⅞-in. squares; 2½, 2 and 1⅛-in. thick edged flats; and three ovals to make 1¼ to 2⅛-in. squares by eighths in the following 3-high stand. The second set receives 10, 9, 8, 6 and 5-in. blooms and makes 6, 4 and 3-in. squares and 2½, 2¼, 2 and 1¾-in. thick edged flats for rerolling or entering the following 18-in., 3-high stand. The third set is used to roll blooms down to the leader pass for finishing large rounds from 4¼ to 5¼ in. inclusive in the 18-in. mill.

The 18-in. mill, being a secondary rougher as well as a finishing stand for large rounds, was designed with top and bottom motorized screwdowns to take full advantage of pass adjustment so vitally necessary when rolling all grades of stainless or alloy steels using three to five passes. Many times a roller on a fixed 3-high rougher or secondary rougher would have liked to have had automatic roller adjustment to make a thicker or thinner oval or flat, or a smaller or larger square but could not because if he adjusted the roll for one pass he would be over or under filled on the next pass used in that roll.

The oval-square pass sequence is used in the intermediate stands for small rounds, while the square-flat-former-oval-round series is used for the larger rounds.

Ultimate maximum flexibility was maintained by providing for future rolling of 13-in. ingots and slabs for sheet bar.

Figure 45 shows a pass layout for the merchant bar mill shown in Figure 8. Billets used are 3, 4 and 5-in. squares. One set of rolls is used in No. 1 and 2 stands, three sets in No. 3 stand and four sets in No. 4 stand to roll all products. This arrangement was made possible by:

1. Entering the 3-in. square into an oval in No. 1 stand pass A followed by a square in No. 2 stand followed by oval-square series of reduction to the continuous finishing mill where the oval-round series is used, and to the first forming passes for angles, channels, flats and sharp cornered squares.

2. Use of box passes in No. 1 stand B and C and edging passes in No. 2 stand B, C, D and E for 4 and 5-in. billets for all sections other than wide flats which are flattened on the bullhead BH in No. 2 stand.

Oval and square sequence is used from No. 3 stand to the first forming pass for all sections, with the exception of wide flats that continue with the flat and edge method from No. 2 stand to the finishing pass and several sizes of large rounds where a diamond is used in

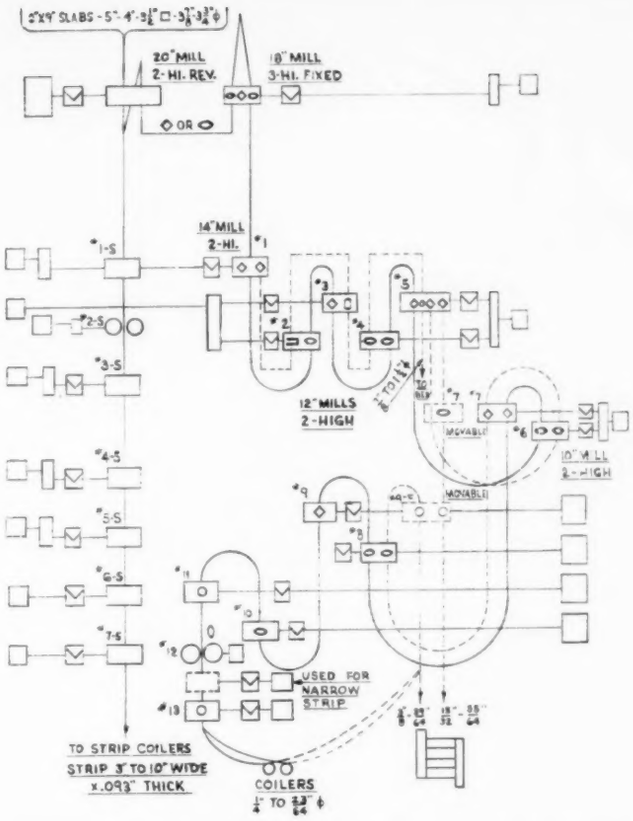


Figure 42 — Suggested pass layout indicates the multiple outlets and by-passing available.

No. 3 stand to make a square in No. 4 stand. The reason for this arrangement is that the size of square required was much larger than could be obtained by using an oval, but necessary stock could be obtained by using the lighter method of reduction, i.e., the diamond-square method.

Referring to Figure 45, it is of interest to note the advantages offered the roll designer and roller by use of certain types of pass reductions, some of which are:

Products from three square passes (two from No. 4 stand E and G and one from No. 8 stand P) enter one bullhead pass BH in No. 9 stand which feeds nine former passes in No. 10 stand followed by nine leader passes in No. 11 stand resulting in 17 finish sizes (15/8 to 2½-in. rounds and No. 14 rebar) in No. 12 stand using the square-flat-former-finish method of reduction.

Products from one square pass in stand No. 10 R enter three leader passes in stand No. 11 S, B and T which make four finishing sizes in stand No. 12 using the square-oval-finish method. Products from one lead round pass in No. 12 stand S enter five leader ovals in stand No. 13 resulting in eight finish round sizes in stand No. 14 using the round-oval-round method of reduction.

While this diagram only shows making rounds and rebar the passes shown from No. 1 stand through No. 8 stand are used for small flats and angles. Sizes ⅜ to 7/8-in. round are finished round-oval-round from No. 14 stand. Sizes 29/32 to 1 9/16-in. round are finished square-oval-round from No. 12 stand. Sizes 15/8 to 2½-in. round are finished square-flat-former-oval-round from No. 12 stand. No. 3 to No. 6 rebar is finished on No. 14 stand and No. 7 to No. 11 rebar is finished on stand No. 12 using the oval-square-leader-finish series.

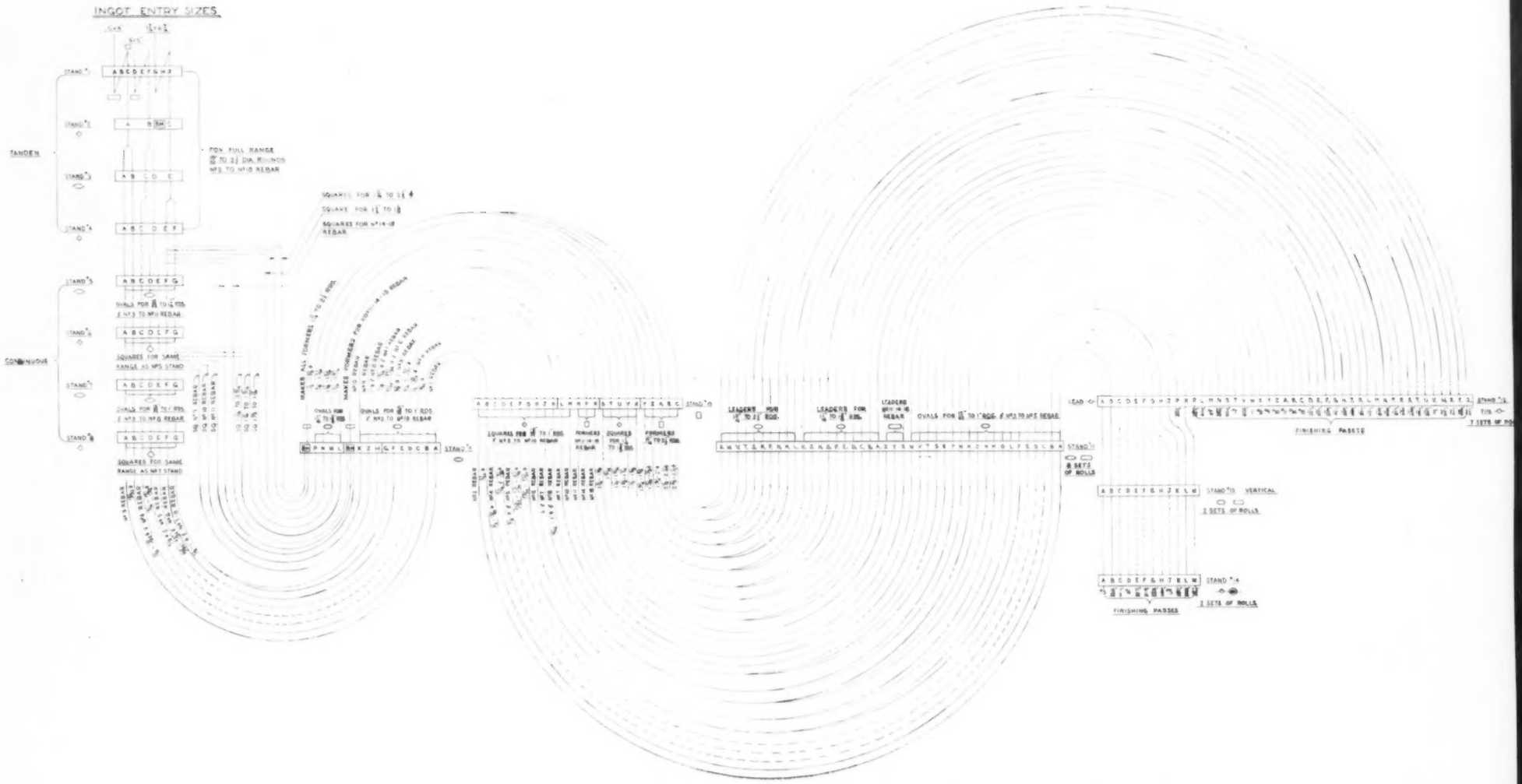


Figure 43 — Three ingot sizes can produce the full range of product because of careful pass layout.

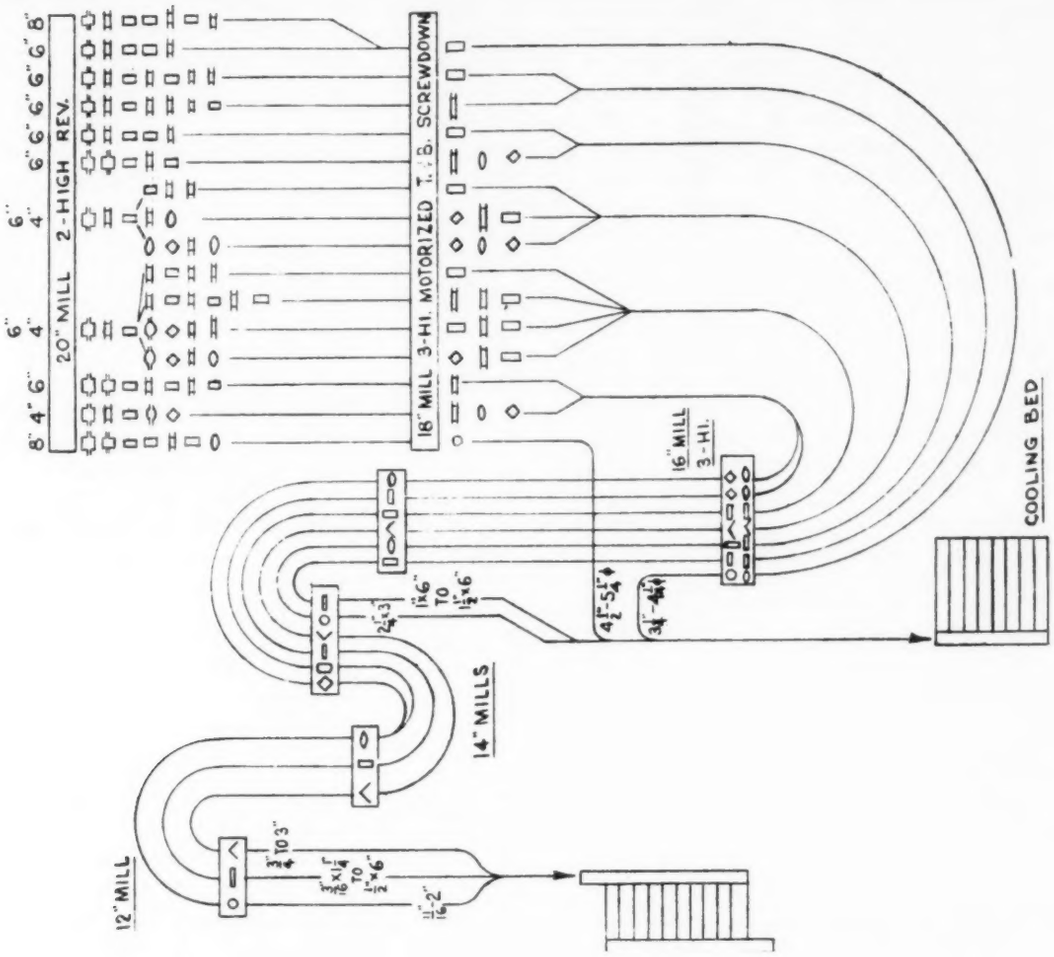


Figure 44 — The secondary rougher is also used as a finishing stand for large rounds.

No. 14 rebar is also finished on No. 12 stand using a square-flat-former-leader-finish sequence. All 14 stands are used from $\frac{3}{8}$ to 0.615-in. round. Sizes of rounds from $\frac{5}{8}$ to $\frac{7}{8}$-in. round by-pass looping stands No. 5 and 6, thus using a total of 12 passes. Sizes $\frac{29}{32}$ to $2\frac{1}{8}$-in. rounds also by-pass stands No. 5 and 6, and dummy stands No. 13 and 14, using a total of ten passes. Sizes $2\frac{3}{16}$ to $2\frac{1}{2}$-in. rounds by-pass stands No. 5, 6, 7 and 8 and dummy stands No. 13 and 14, using a total of eight passes.

Similar arrangement of by-passing stands is used in the rolling of flats, squares, angles, channels and rebar. Sales forecast data is used to great advantage in laying out the passes in the rolls. Typical projected tonnage by sizes showed that 34 sets of finishing rolls were necessary for plain rounds and rebar alone. Certain popular sizes of round finishing grooves that might be used in every rolling were duplicated in several sets of rolls to prevent changing a set of rolls after using only several sizes of finishing groove. Provision was made in the roll layout to change from 3-in. square billet to 4 in., the 4 to 5 in. and the 5 to 6 in. in the future. The number of mill stands and width of pass collars are sufficient to absorb this future change.

By providing a bullhead pass in the No. 1 stand of rolls provision is also retained for future rolling of 6 x 4-in. billet to 6-in. wide flats from $\frac{1}{2}$ to $1\frac{1}{2}$-in. thick.

There are some unusual methods used in rolling and in roll pass design to reduce downtime. One which has been adopted by several companies for rolling stainless flats, is edging on the barrel of the roll instead of using the edging grooves which are standard in the mild steel industry.

Since orders for stainless flats are very small, the need for eliminating edging groove passes and roll changes was felt necessary.

This end is accomplished by using stepped rolls, dropping the bottom roll according to the width of the flat, and using flat side guides with very little clearance for the bar to enter. The closer the side guides are set to the thickness of the flat entering, the squarer will be the corners. If the clearance is too great the flat will lean causing the edges to go long cornered.

While this method limits the length of the flat being rolled, compared with lengths that are rolled in edging grooves in the mild steel industry, it is still being used where size changes are frequent. The reason for limitation of length of finish bar is because the bottom roll is dropped considerably for edging wide flats causing the pass line for edging narrow flats to be high above floor line and long bars tend to lay flat on the mill floor, requiring them to be turned on edge by the entry guides and resulting in excessive wear on the entry guides, thus causing the bar to lean between the rolls and the edges of the flat to be out of square. Figure 46 shows a suggested roll pass setup for rolling flats on the barrel and the comparable layout for using edging grooves.

After the final roll pass chart has been developed

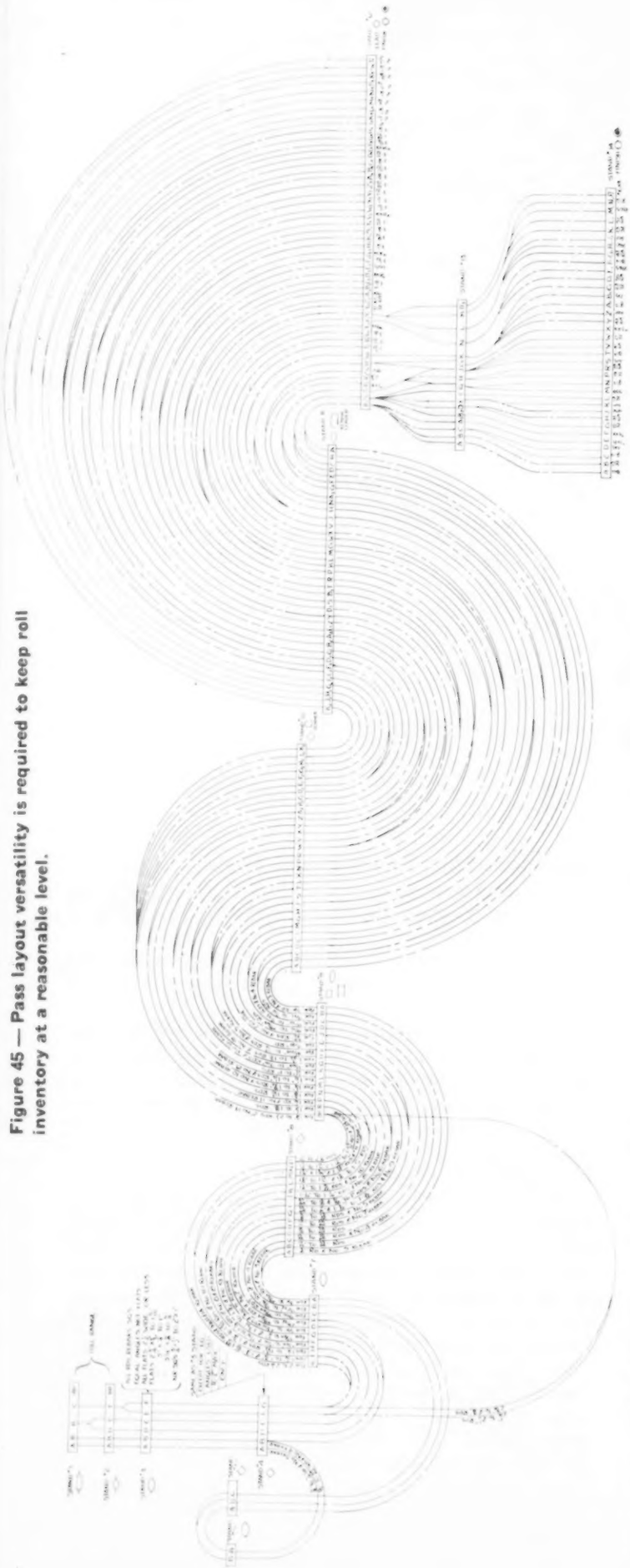


Figure 45 — Pass layout versatility is required to keep roll inventory at a reasonable level.

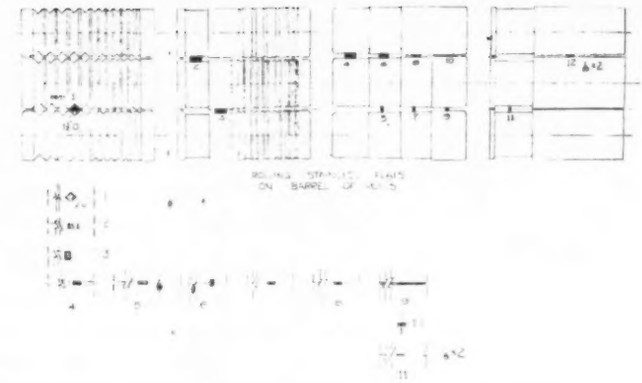
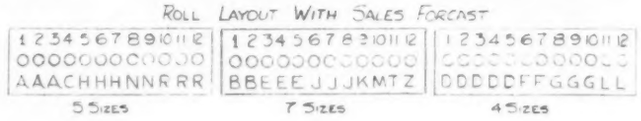


Figure 46 — Stainless flats are often rolled on stepped rolls.


ROLL LAYOUT WITH SALES FORCAST
1 2 3 4 5 6 7 8 9 10 11 12
A A A C H H H N N R R R
5 SIZES
1 2 3 4 5 6 7 8 3 10 11 12
B B E E E J J J K M T Z
7 SIZES
1 2 3 4 5 6 7 8 9 10 11 12
D D D D F F G G G L L
4 SIZES

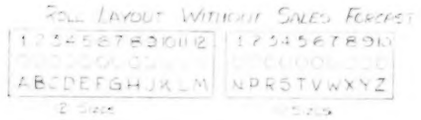


Figure 47 — A sales forecast pattern is helpful in roll pass design.

and before laying out the passes in the rolls, it is necessary for the roll designer to have data pertaining to sales pattern of sizes and sections. This is important in deciding the number of duplicate grooves throughout the mill in order to avoid changing rolls in the middle of a size, regrooving excessive number of passes, that were not used or were used very little, or using too many duplicate passes thereby creating excessive roll changes.

It is true that the pattern of business may change from time to time; however, the roll designer should closely follow these changes and rearrange the grooving of various rolls accordingly.

Figure 47 shows three sets of finishing rolls for rounds; having a total number of 36 passes for 16 sizes.

Set No. 1 has a total of 12 passes for five sizes: three A passes, one C, three H, two N and three R.

Set No. 2 has a total of 12 passes for seven sizes: two B passes, three E, three J and one each for K, M, T and Z.

Set No. 3 has a total of 12 passes for four sizes; five D passes, two F, three G and two L.

Without a projected sales pattern it is obvious that the roll designer would have placed these 16 sizes in two sets of rolls instead of three as shown. However, on this particular mill the designer knew the tonnage required of pass D was much greater than the rest, and that the tonnage required of passes K, M, T and Z was very low. By providing enough duplicate groove he avoids changing rolls for size D before completing the rolling.

It is hoped that this article has shown, not only the means by which flexibility is preserved in mechanized merchant bar mills, but also that flexibility is not an end in itself, and must be emphasized only in relation to all other mill objectives, some of which may be in conflict with it.

Discussion

PRESENTED BY

LOUIS MOSES, Bethlehem, Pa.

Louis Moses: The industry erects its mills to produce rolled products at maximum efficiency. In doing so it must achieve satisfactory returns on the capital investment and a profit on operating expense. The specialized mills, which roll essentially the same products at all times, offer the least problems. The rolling of a wide variety of commodities entails many considerations applying to the arrangements of the mill stands and their drives. In their exploration of flexibility the authors have drawn upon the many mill types in existence and describe the complexities which must be resolved.

From the standpoint of mill builders, the authors do not touch upon the projections which a wise management must necessarily employ when deciding upon a particular mill type or size. Although affecting revamping projects to a considerable degree, forecasting of possible changes particularly applies to completely new installations. An attractive proposition will be within the limits of an appropriation and will satisfactorily meet currently seen demands. How long will the presently known market continue? What direction will the trade take for other sections? For instance, years ago certain mills were prime producers of toecalk but for many of the later years have rolled the far more demanding sections for automobiles, window sash, etc. What competition will develop from other companies installing similar equipment? What other products can be rolled? Will other materials supplant certain sections, and, if so, what can the projected mill then produce? Will it become necessary to meet drastically reduced tolerances over those which are presently accepted or established? Will presently impossible coil weights be demanded by many customers? What new conceptions of drives are in the making, such as rectifiers displacing motor-generators, and, indeed, can a merchant mill be designed to use a-c exclusively? Will carbon steel bar production yield materially to low content alloy grades offering characteristics of heating and higher roll-separation forces which should be inherent in the new mill's ability?

The serious nature of deciding upon the design and equipment of a new merchant mill is emphasized when realizing that some in existence were installed at the turn of the century. Others, more than 30 years old, continue to be known as the "new mill." Layouts, auxiliaries, cooling beds, drives, etc., vary from the original designs, modifications having been made in the interim to meet product changes, etc. Except as they may display some particular advantage or disadvantage of a specific phase of rolling these mills are generally far from ideal.

No management, operating supervisor or engineer desires to erect a "monument" during his tenure of service. However, faced with a forcing need for improvement, decisions must be made. ▲

COLORADO FUEL AND IRON'S BASIC OXYGEN SHOP*

by GEORGE GROSVENOR

Superintendent, Steel Production, Colorado Fuel and Iron Corp., Pueblo, Colo.

IN 1959, Colorado Fuel and Iron Corp. made the decision to build a basic oxygen shop having an ingot capacity of 50,000 net tons per month. The basic oxygen shop layout is to be typical in that it will consist primarily of a scrap aisle, charging aisle, furnace aisle and teeming aisle. It is to be a 2-furnace shop; one operating and the other being relined or on standby. The furnace shell is to be 18 ft-6-in. ID and 27-ft high, with a volume of 2810 cu ft after lining, to produce a nominal heat size of 100 net tons. Charging of scrap will be accomplished in 30 sec using approximately 22 tons of light scrap (45 lb per cu ft). After the hot metal is added the blowing of oxygen will proceed at a rate of 8000 to 10,000 cfm. Tap-to-tap time should be less than one hr.

Dry type electrostatic precipitators will be employed to remove solids from the flue gas. Fan capacity will be 300,000 cfm at 350 F. The fan, driven by a 700-hp motor, will draw ten in. of water column at the precipitator header. A pug mill is to be used to remove dust from the precipitator hoppers.

Auxiliary shop equipment will consist of one 15-ton crane for scrap handling; one 125-ton crane in the charging aisle; and one 125-ton crane in the teeming aisle. Three 7000-lb fork trucks with rotary heads will be used to handle alloys and refractories, and car pullers will be used to move blast furnace torpedo cars. A rubber tired car mover will be used to move scrap and flux cars, and a 6-ton elevator located south of the furnaces will be incorporated to move spare parts, refractories and lift trucks to the various levels. Transfer cars for the teeming ladles and slag pots are capable of working in tandem using power from only one of them. Initially, eight 100-ton teeming ladles and 20 slag pots of 260-cu-ft capacity will be available for use in the shop.

Water supply will be received under 80 psi and raised to 150 psi for lance cooling at the rate of 250 gpm. Hood cooling water will be used at 80 psi and then repumped for spray water at 50 psi.

Carloads or truckloads of burned limespar, mill scale and ore are to be dumped into the flux unloading hopper, from where belt conveyors will lift the raw materials to the five 4000-cu-ft day bins and then to a batch hopper with a capacity of 480 cu ft.

Ladle setup will be accomplished in the teeming aisle area between the furnaces on ladle stands able to rotate 180 deg to dump slag and debris. Slag pots will load onto trucks at either end of the charging aisle.

The oxygen plant which will supply the shop is located outside the plant and will furnish 280 net tons per day with a line pressure of 185 psi. Storage facilities are: liquid equivalent of 10,000,000 cu ft and a gaseous surge of 200,000 cu ft. ▲

* Abstracted from a talk presented April 11, 1961, at the AIME Annual Conference in Philadelphia, Pa.

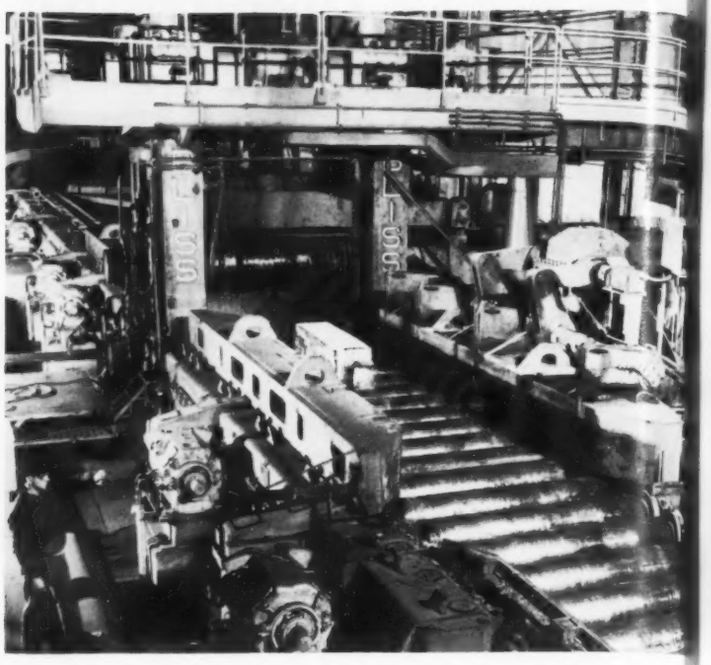


Figure 1 — An ingot approaches the rolls of a 40 x 90-in. reversing blooming mill.

How to Get and Use Rolling Mill Power Data

by A. J. WINCHESTER

Chief Electrical Engineer, Rolling Mill Div., E. W. Bliss Co., Canton, Ohio

. . . . selection of motor size for any rolling mill is an important decision—each mill has an individual set of power requirements which must be satisfied to obtain the desired production rate. . . .

DERIVATION and application of rolling mill power data is not difficult. A knowledge of how to determine the power required is important in the selection and use of rolling mills. What size motor is required? This is one of the most important decisions when a mill is designed. An appreciation of how power data is obtained is beneficial. Comprehension of the basic concepts involved is essential for the study of production schedules and calculation of motor rating. The fundamental principles are not difficult to understand.

Two basic systems are commonly used to determine the power required to elongate metal by passing it between two rolls. These systems are usually referred to as the specific power consumption and the hp-hr per net ton rolled methods. The abbreviations are SPC and HHT. The latter is the most commonly used system and usually gives the most accurate results.

SPECIFIC POWER CONSUMPTION

Specific power consumption is not a good term because power is the rate of doing work, and it is not possible to consume a rate. This name was given to this system of calculation many years ago and has continued in general usage ever since.

An SPC curve is made by plotting a curve with per cent of original area as the abscissa and hp-sec per cu in. displaced as the ordinate as shown in Figure 2. Area is the cross-sectional area of the material in a plane parallel to the plane through the axis of both rolls. The power required for a given pass through the mill is determined by the following procedure:

1. Determine the rate at which the metal is displaced as it passes through the mill at a constant speed. This is measured in cu in. displaced per sec and is given by the following formula:

$$\text{Cips} = \frac{\text{fpm}}{5} \times \frac{A_2}{A_1} (A_1 - A_2)$$

Cips = Cu in. displaced per sec
A_1 = Cross-sectional area in sq in. of metal before the pass
A_2 = Cross-sectional area in sq in. of metal after the pass
fpm = Delivery speed in ft per min

2. Find the per cent area at the beginning of the pass. This is the cross-sectional area of the metal before it enters the rolls for a particular pass (N) divided by the cross-sectional area of the metal before the first pass expressed as per cent. It is given by the following formula:

$$\text{Per cent area at beginning of pass N} = \frac{\text{cross-sectional area before pass N}}{\text{cross-sectional area before first pass}} \times 100$$

3. Read from the applicable SPC curve the SPC for the per cent area at the beginning of the pass.

4. The rolling horsepower required for the pass is the product of the cu in. displaced per sec as obtained in step 1 and the SPC or hp-sec per cu in. displaced as obtained in step 3.

$$\text{Rolling hp} = \text{Cips} \times \text{SPC}$$

A typical sample of an SPC calculation is given in example 1. The SPC value used in this example was obtained from the curve in Figure 2.

HP-HR PER NET TON

For HHT a curve with elongation as the abscissa and hp-hr per net ton rolled as the ordinate is used as shown in Figure 3. The material has an elongation of one before the first pass, and the elongation after any pass is equal to the length after the pass divided by the initial length before the first pass. The power required for a given pass is obtained with the following procedure:

1. Find the elongation of the metal after the pass. This is obtained by dividing the cross-sectional area of the metal before the first pass by the cross-sectional area of the metal after the pass in question as shown in the following formula:

$$\text{Elongation at completion of Pass N} = \frac{\text{cross-sectional area before first pass}}{\text{cross-sectional area after pass N}}$$

2. Find the elongation of the metal before the pass. This is obtained by dividing the cross-sectional area of the metal before the first pass by the cross-sectional area of the metal before the pass in question (N) as shown in the following formula:

$$\text{Elongation before pass N} = \frac{\text{cross-sectional area before first pass}}{\text{cross-sectional area before pass N}}$$

3. Read from the applicable HHT curve of hp-hr per ton for the elongation before the pass.

4. Read from the applicable curve the hp-hr per ton for the elongation after the pass.

5. Find the incremental hp-hr per net ton rolled (ΔHHT) which is the difference between that for the elongation after the pass and that for the elongation before the pass.

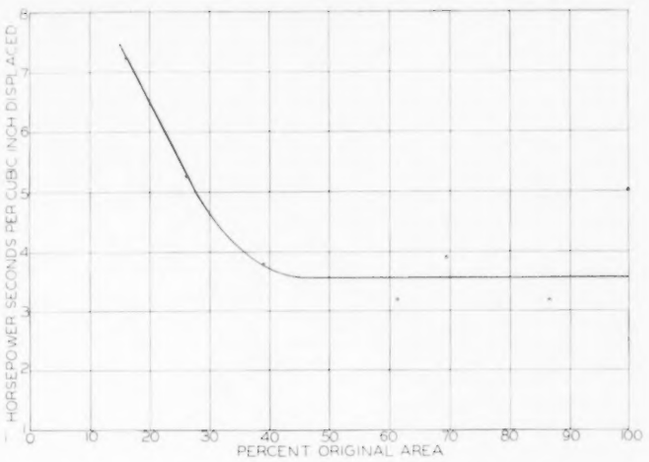


Figure 2 — An SPC curve has hp sec per cu in. displaced as the ordinate and per cent of original area as the abscissa. The points from which the curve is drawn are obtained from test data as shown in Example 4.

6. Find the tons per hr delivered from the rolls for the pass when the mill is running at constant speed. This is obtained from the following formula:

Tons per hr = W × T × fpm × 0.36 × D
W = Metal width, in.
T = Metal thickness, in.
fpm = Delivery speed in ft per min
D = Density of metal in lb per cu in.

7. The rolling horsepower required for the pass is the product of the incremental hp-hr per ton obtained in step 5 and the tons per hr delivered from the pass obtained in step 6 as shown in the following formula:

$$\text{Rolling hp} = \Delta\,\text{HHT} \times \text{tons per hr}$$

A typical example of how to calculate the power required for a pass is shown in example 2, using the HHT curve in Figure 3. Note that the rolling horsepower which is calculated using HHT in this example is close to that which was obtained using SPC in example 1; the difference is the accuracy with which the power curves are read.

Either system will give accurate results when properly used to determine the power required to roll metal, but HHT is most commonly used and is better suited for most power data calculations. The relationship between the two systems is given in the following formula:

$$\text{HHT} = \text{SPC}_1 \times \frac{0.555}{\text{density}} \times \left(\frac{E_2 - E_1}{E_2}\right)$$

SPC_1 = SPC for per cent area before the pass
E_2 = Elongation after the pass
E_1 = Elongation before the pass

This relationship may be used to convert data obtained from a curve plotted for one system to data for plotting a curve for the other system.

When data from one system is converted to data for the other system, it is important that the increments used are the same as or close to those from which the original data was obtained. The reason for this is shown in example 3. When HHT is used to calculate the total energy required for a given reduction, the answer ob-

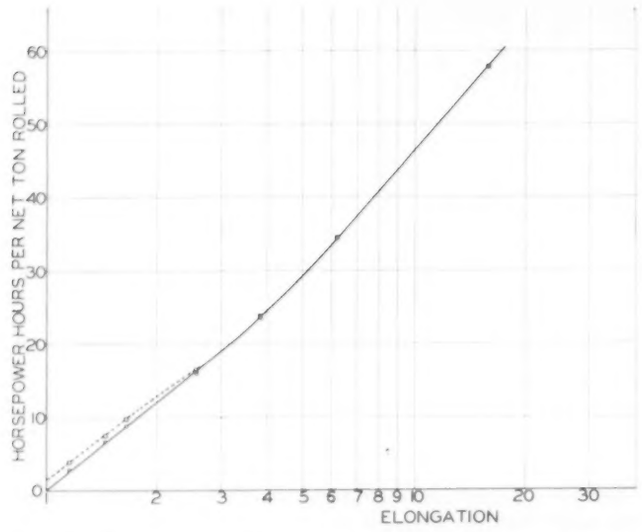


Figure 3 — An HHT curve has hp-hr per net ton rolled as the ordinate and elongation as the abscissa. The solid curve was obtained by conversion from the SPC curve shown in Figure 2, following the procedure in Example 4. The dotted line shows the distortion of the curve which occurs when HHT is calculated directly from test data with one point which is not accurate as shown in Example 4.

tained is the same regardless of the number of passes used, but when SPC is used, the answer obtained varies according to the number of passes. In example 3 it is assumed that SPC is a constant and equal to two. For the 6-pass schedule the elongation is multiplied by 1.25 for each pass. This means that the cross-sectional area of the material after the pass is equal to the cross-sectional area before the pass divided by 1.25. The hp per net ton rolled values were obtained by using the formula which equates the systems with an elongation multiplication of 1.25 and SPC equal to two. With the 6-pass schedule the total energy required is the same, 24,000 hp-sec, when the calculation is made with either system. However, when the reduction is made in one pass the SPC system indicates that the energy required is 14,760 hp-sec. When HHT is used, the answer obtained is the same regardless of the number of passes used. This shows that the SPC system will give an incorrect answer if the increments used are not close to those from which the original power curve was obtained.

DERIVATION OF POWER CURVES

In most cases the data required to plot power curves is obtained by making tests on existing mills. This is done as shown in example 4. The following information is required:

1. Cross-sectional area or initial width and thickness of the material before the first pass.
2. Temperature of the material before the first pass if it is hot rolled.
3. Cross-sectional area or width and thickness of the material after each pass.
4. Delivery speed of the material for each pass.
5. Rolling horsepower for each pass.

With this information the data required to plot an HHT curve may be calculated directly. The formulae required are:

$$\text{Rolling hp} = \text{Mill motor hp plus pull tension hp minus drag tension hp}$$

$$\text{Motor hp} = \frac{\text{volts} \times \text{amp}}{746} \times e$$

$$e = \text{per unit efficiency of motor}$$

$$\text{Drag generator hp} = \frac{\text{volts} \times \text{amp}}{746} \times e$$

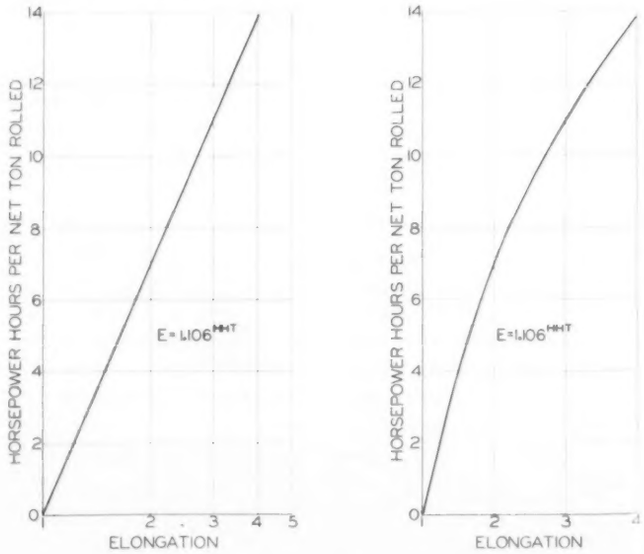
$$\text{Tension hp} = \frac{\text{lb tension} \times \text{fpm}}{33{,}000}$$

In obtaining data for preparation of power curves, it is important to read the motor horsepower when the mill is operating at constant speed. The energy to make a given reduction from a power data curve does not include any allowance for acceleration or deceleration; only the energy which is required to roll the metal is indicated.

If there is tension in the metal, this must be taken into account. The rolling horsepower is that which is required to reduce the metal. For example, suppose power data is taken on a multi-stand tandem mill with strip tension between stands. The rolling horsepower for a given stand is equal to the horsepower output of the motor coupled to that stand, plus the horsepower from tension in the strip coming out of the stand, minus the horsepower from tension in the strip going into that stand. The relationship is the same for a single stand mill with pullers and reels.

A power curve for hot rolling should always indicate the temperature of the metal before it is rolled, and it is

Figure 4 — When the energy required to produce a given multiple of elongation is the same regardless of the initial elongation, the metal has uniform characteristics of deformation, and the HHT curve is a straight line on semi-logarithmic co-ordinates. The constant which in this case is 1.106, is determined by the slope of the line. This curve when plotted on rectangular co-ordinates is not a straight line. It is easier to observe variation of the deformation characteristics of the metal when the curve is plotted on semi-logarithmic co-ordinates.



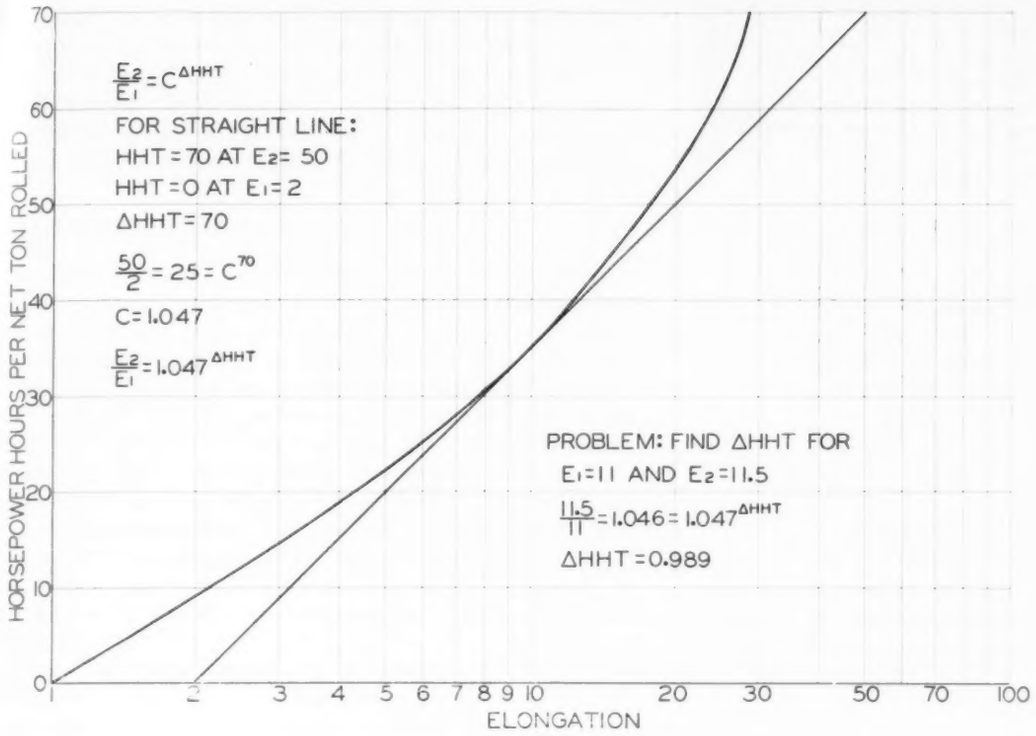


Figure 5 — For a small change in elongation the incremental HHT which is difficult to accurately determine by subtraction of values read directly from the curve may be determined exactly using the procedure shown. This is derived from the relationship that a straight line on semi-logarithmic co-ordinates is represented by:

E = C^{HHT}
E = Elongation
C = Constant
HHT = Hp-hr per net ton

desirable to know the temperature after the last pass. The energy required to make a given elongation decreases as the temperature of the metal increases.

When metal is annealed the power curve for subsequent passes is based on an elongation of one for the metal before the first pass after it is annealed. The same is true when metal is cold rolled after hot rolling. This is because of the drastic changes in deformation characteristics which are caused by changing from hot rolling to cold rolling and by annealing.

There is a disadvantage in going directly from test data to hp-hr per net ton rolled. Because the incremental hp-hr per ton obtained from each pass are totaled to obtain the hp-hr per ton curve, an error has a cumulative effect. If the data is calculated in the form of SPC, points which are in error are more easily detected. The SPC data from example 4 is plotted in Figure 2. The value of SPC (5.01) for an initial area of 100 is obviously high in comparison with the other points which are near to it; therefore, it is safe to assume that the data from which this pass was calculated is not accurate. When the SPC curve was drawn, this point was neglected, and the curve is the average of the balance of the points. As shown in example 4, the SPC value as read from the curve is used to calculate the incremental hp-hr per ton for each pass. A comparison of the two curves obtained is shown in Figure 3. The solid curve is that which was obtained by first calculating SPC, and then converting to HHT using the SPC values read from the averaging curve in Figure 2. The dotted line in Figure 3 shows the deviation or inaccuracy which would have occurred in the hp-hr per ton curve if HHT was calculated directly from the test data. The advantage of SPC is that each pass is considered as an entity so that errors are not cumulative. If the test data involves enough passes that it is feasible to plot an SPC curve and obtain average values for calculation of the incremental hp-hr per ton, it is best to follow this procedure because it minimizes the possibility of error shifting the total hp-hr per ton curve.

SUGGESTIONS ON USING HHT

It is desirable to plot an HHT curve on semi-logarithmic co-ordinates, then it is readily apparent if the material has uniform deformation characteristics. If the HHT curve is a straight line, the energy required to make a given multiplication of elongation is the same regardless of the initial elongation. As shown in Figure 4 an HHT curve which is a straight line on semi-logarithmic co-ordinates is not a straight line on rectangular co-ordinates, so it is not easy to observe the deformation characteristics of the metal when the curve is plotted on rectangular co-ordinates.

If the curve is a straight line on semi-logarithmic co-ordinates, the material is not work hardening. In some rare cases the result of successive passes is to increase the temperature of the metal to the point where it is easier to roll, so that the curve on semi-logarithmic co-ordinates actually bends down with increased elongation. With work hardening the energy required to produce a given multiple of elongation increases which makes the curve on semi-logarithmic co-ordinates increase in slope with elongation.

Sometimes it is necessary to calculate the horsepower required for a pass in which the change in elongation is so small it is difficult to accurately read the incremental hp-hr per net ton rolled from the curve used. A method of accurately determining the incremental hp-hr per net ton rolled for this condition is shown in Figure 5. A straight line HHT curve on semi-logarithmic co-ordinates may be represented by the following equation:

$E = C^{HHT}$
E = Elongation
C = Constant

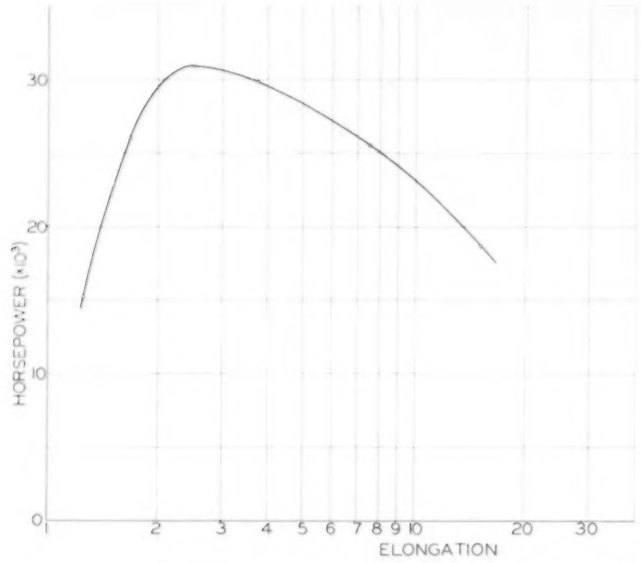


Figure 6 — A curve with elongation vs horsepower with constant delivery speed is helpful in determining the peak horsepower required. Horsepower is equal to the product of HHT, which increases with the elongation, and tons per hr, which decreases with elongation.

A straight line which is not through the origin may be represented by the following equation:

$$\frac{E_2}{E_1} = C\Delta HHT$$

ΔHHT = Incremental HHT from E_1 to E_2

A straight line is drawn tangent to the HHT curve at the point where it is desired to determine the incremental hp-hr per net ton rolled. From this straight line as shown in Figure 5 the incremental hp-hr per net ton rolled is determined. The equation shown is easily solved on a slide rule with log-log scales.

Some people prefer to plot material thickness instead of elongation vs hp-hr per net ton rolled. The disadvantage of strip thickness as the abscissa of an HHT curve is that a new curve is required for each different initial material thickness. Frequently a single elongation curve will cover a range of initial material thickness. When elongation is used for an HHT curve, it is best to indicate on the curve the range of initial material thickness that is represented. This curve may then be used over the entire range without plotting a new curve for each different initial thickness.

PEAK ROLLING HORSEPOWER

In making a study to determine the power required for a mill it is helpful to plot a curve showing total rolling horsepower vs elongation with constant strip delivery speed for the range of elongations involved. This will show the peak horsepower required. The rolling horsepower is equal to the product of tons per hr delivered and hp-hr per net ton for the elongation. Tons per hr decreases with elongation if the delivery speed is held constant. The hp-hr per ton increases with elongation. Therefore, there is a point as elongation is increased, at which a peak horsepower is reached as shown in Figure 6. The data from which Figure 6 was obtained is in example 5.

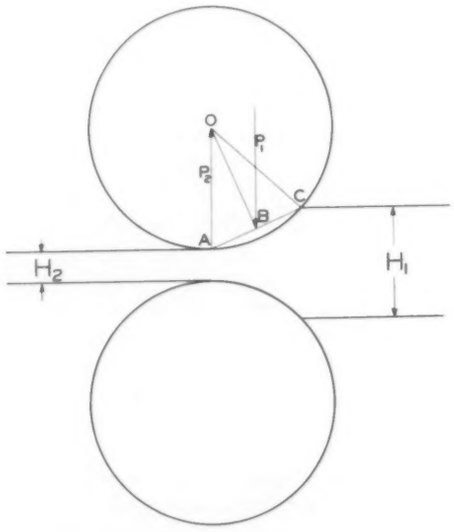
ROLL SEPARATING FORCE

Bearing load or roll separating force is important to both designers and users of rolling mills. The approximate total bearing load or roll separating force is given by the following formula:

$$P = \frac{hp \times 63{,}000}{rpm\sqrt{R(h_1 - h_2)}}$$

P = Roll separating force
hp = Rolling hp
rpm = Roll speed, revolutions per min
R = Roll radius, in.
h_1 = Strip thickness before pass, in.
h_2 = Strip thickness after pass, in.

This is derived from the assumption that it is possible to resolve the total force on the strip into a single vector which acts at the center of the arc of contact and that it is also possible to resolve the total bearing load into a single vector which acts in a vertical line through



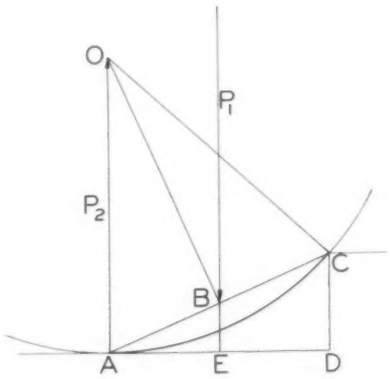


Figure 7 — The approximate total roll separating force or bearing load is determined by the relationship shown. This is based on the assumption that the summation of the force on the strip (P1) is equal, opposite, and parallel to the summation of the total separating force or bearing load (P2).

$$P_1 = P_2 = \frac{HP \times 63000}{RPM\sqrt{R(H_1 - H_2)}}$$

the center of the bearing. The development of the formula which gives the total separating force is given in the appendix. There is no simple exact system of calculating separating force, and much has been said and written concerning this. The formula given here is approximate but is sufficiently accurate for most applications. The relationship between force on the strip and roll separating force as assumed for this formula is shown in Figure 7.

ROOT MEAN SQUARE HORSEPOWER

Sometimes it is possible to consider the duty cycle on a mill and select a motor with a continuous rating less than the peak rolling horsepower required. The most frequently used method of determining the rating required for continuous operation without overheating of a motor is known as root mean square, which is based on the assumption that motor heating is proportional to the square of power output. While this assumption is not completely true, it is generally accepted as sufficiently accurate for use in determination of motor horsepower. The root mean square (rms) horsepower for a given rolling horsepower is found with the following formula:

$$\text{rms hp} = \sqrt{\frac{\text{rolling time}}{\text{total time}}}\ \text{rolling hp}$$

SUMMARY

Hp-hr per net ton rolled is best suited for most power data calculations. Use a curve which is plotted on semilogarithmic paper. Remember that the slope of the curve indicates whether the material is becoming easier to work, remaining the same, or becoming more difficult to roll.

APPENDIX

Torque = lb × in.

P_1 = Roll force in lb (Figure 7) on strip which represents the summation of the roll force on the strip and is assumed to act in a line parallel to OA at the midpoint of the straight line AC which connects the end points of the arc of contact.

P_2 = Roll separating force in lb which represents the summation of the roll force on the bearing and is assumed to act from the end of the arc of contact to the center of the bearing in the line OA.

$P_1 = P_2 = P$ When the roll is operating at constant speed, the moment required to roll the strip is equal to the torque supplied to the roll from the source of power. P_1 and P_2 form a couple, the moment of which is equal to the torque supplied to the roll.

$P \times AE$ = Torque supplied to roll

AOB and ACD are similar triangles.

TABLE I
Example 1

Specific power consumption calculations. What power is required to reduce a slab 40-in. wide from 3 to 2 in. in thickness? The initial thickness before the first pass was 7.5 in. The rolling speed is 400 fpm, and the density of the material is 0.1 lb per cu in.

$A_1 = 3 \times 40 = 120$
$A_2 = 2 \times 40 = 80$

$$400 \times \frac{80}{120}(120 - 80)\frac{1}{5} = 2133 \text{ cu in. displaced per sec}$$

$$\frac{120}{40 \times 7.5} \times 100 = 40 = \text{Per cent area before the pass}$$

SPC = 3.83 for 40 per cent area from curve
$2133 \times 3.83 = 8169$ hp = Rolling hp

TABLE II
Example 2

Hp-hr per net ton rolled calculations. The problem and initial conditions are the same as for example 1.

$$E_1 = \frac{7.5 \times 40}{3 \times 40} = 2.5 = \text{Elongation before the pass}$$

$$E_2 = \frac{7.5 \times 40}{2 \times 40} = 3.75 = \text{Elongation after the pass}$$

23 = hp-hr per ton from curve for $E_2 = 3.75$
15.9 = hp-hr per ton from curve for $E_1 = 2.5$
7.1 = Incremental hp-hr per ton for pass

$40 \times 2 \times 400 \times 0.36 \times 0.1 = 1152$ = tons per hr
$7.1 \times 1152 = 8179$ hp = rolling hp

TABLE III
Example 3

Pass	Area after pass	Difference in area	Length before pass	Volume displaced	Hp × sec
0	100.00				
1	80.00	20.00	100	2000	4,000
2	64.00	16.00	125	2000	4,000
3	51.20	12.80	156.3	2000	4,000
4	40.96	10.24	195.3	2000	4,000
5	32.77	8.19	244.1	2000	4,000
6	26.21	6.56	305.2	2000	4,000
					24,000
0	100				
1	26.21	73.8	100	7380	14,760

Initial dimensions of bar rolled = 10 × 10 × 100 in.
Density of material = 0.1 lb per cu in.
Volume of bar = 10 × 10 × 100 in. = 10,000 cu in.
Weight of bar = 10,000 × 0.1 = 1000 lb.

Hp-sec from SPC equals a constant (2).

Pass	Area after pass	Elongation after pass	HHT after pass	HHT difference	Hp × sec
0	100.00	1	0		
1	80.00	1.25	2.22	2.22	4,000
2	64.00	1.56	4.44	2.22	4,000
3	51.20	1.95	6.66	2.22	4,000
4	40.96	2.44	8.88	2.22	4,000
5	32.77	3.05	11.10	2.22	4,000
6	26.21	3.82	13.32	2.22	4,000
					24,000
0	100				
1	26.21	3.82	13.32	13.32	24,000

$$\text{HHT} = \frac{\text{hp} \times \text{hr}}{\text{ton}}$$

$$\text{Hp} \times \text{sec} = \text{HHT} \times \text{tons rolled} \times 60 \times 60 = \text{HHT} \times \frac{1000}{2000} \times 3600 = \text{HHT} \times 1800$$

Hp-sec from HHT.

TABLE IV
Example 4

Pass	1	2	3	4	5	6	7
Width, in.	45	45	45	45	45	45	45
Thickness before pass, in.	7.5	6.49	5.20	4.60	2.93	1.96	1.21
Thickness after pass, in.	6.49	5.20	4.60	2.93	1.96	1.21	0.50
Mill speed, fpm	368	292	602	396	439	425	451
Rolling hp	14,500	8,650	11,250	12,100	9,735	9,310	8,600
Tons per hr	3,869	2,460	4,487	1,880	1,394	833	365
Hp-hr per ton per pass	3.75	3.52	2.51	6.44	6.98	11.17	23.6
Total hp-hr per ton	3.75	7.27	9.78	16.22	23.20	34.37	57.97
Elongation	1.155	1.44	1.63	2.56	3.83	6.20	15.0
Original area before pass, per cent	100	86.5	69.3	61.3	39.1	26.1	16.1
Cu in. displaced per sec	2,894	2,715	2,874	3,785	2,560	1,770	1,190
Calculated hp-sec per cu in. displaced	5.01	3.19	3.91	3.20	3.80	5.26	7.23
Hp-sec per cu in. displaced from curve	3.55	3.55	3.55	3.55	3.88	5.08	7.21
Hp-hr per ton per pass	2.64	3.92	2.3	7.15	7.14	10.78	23.5
Total hp-hr per ton	2.64	6.56	8.86	16.01	23.15	33.93	57.37

TABLE V
Example 5

Pass	0	1	2	3	4	5	6
Width, in.	45	45	45	45	45	45	45
Thickness after pass, in.	7.5	6	4.5	3	2	1	0.5
Mill speed, fpm	400	400	400	400	400	400	400
Tons per hr		3,890	2,916	1,944	1,296	648	324
Elongation	1	1.25	1.667	2.5	3.75	7.5	15
Total hp-hr per ton	0	3.9	8.9	15.9	23	39.3	57.8
Rolling hp		15,170	25,950	30,910	29,810	25,470	18,730

$$\therefore \frac{AO}{AC} = \frac{AB}{CD}$$

$$AO = R$$

$$AC = 2AB$$

$$CD = \frac{h_1 - h_2}{2}$$

$$(AC)^2 = R(h_1 - h_2)$$

$$(AC)^2 = (CD)^2 + (AD)^2$$

$$R(h_1 - h_2) = \frac{(h_1 - h_2)^2}{4} + (AD)^2$$

$AD = \sqrt{R(h_1 - h_2) - [(h_1 - h_2)^2/4]}$. Since $(h_1 - h_2)^2/4$ is very small compared to $R(h_1 - h_2)$, the expression for AD may be reduced to: $AD = \sqrt{R(h_1 - h_2)}$.

$$AE = \frac{AD}{2}$$

$P\sqrt{R(h_1 - h_2)}$ = Torque supplied to two rolls

$$Hp = \frac{\text{Torque} \times \text{rpm}}{63{,}000}$$

$$Hp = \frac{P\sqrt{R(h_1 - h_2)} \times \text{rpm}}{63{,}000}$$

$$P = \frac{hp \times 63{,}000}{\text{rpm}\ \sqrt{R(h_1 - h_2)}}$$

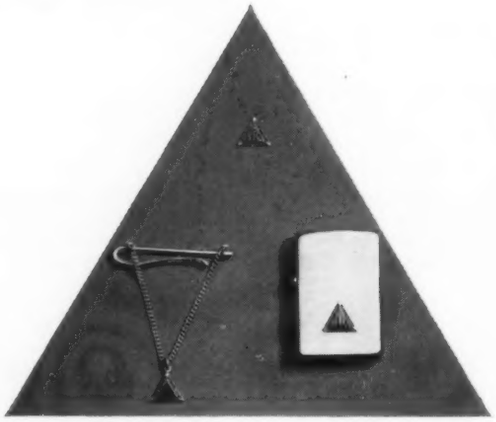
▲

AISE Accessories Available To Members

• MEMBERSHIP PIN—complete with plastic case, finished in handsome blue and gold— $2.00

• TIE CLASP—gold plated tie bar and matching chain with AISE insignia, in attractive plastic case— $5.00

• LIGHTER—famous-make Zippo, in brush finish stainless case with embossed AISE insignia— $6.00



ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 Empire Building **Pittsburgh 22, Pa.**

TENTATIVE PROGRAM

Association of Iron and Steel Engineers

1961 Annual Convention

HOTEL PENN-SHERATON PITTSBURGH, PA.

SEPTEMBER 25, 26, 27, 28

MONDAY, SEPTEMBER 25

9:00 am—REGISTRATION—
Fort Duquesne Room

9:15 am—BUSINESS MEETING—
Urban Room

Conducted by President C. E. Pritchard

9:30 am—ELECTRICAL SESSION—
Urban Room

Chairmen: John F. Kostelac, Division Superintendent, Maintenance, Midland Plant, Crucible Steel Co. of America, Midland, Pa.

James A. B. Pinney, Assistant Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

"Recent Developments and Operating Experience in Control of Gage and Set Up of Strip Mills," by R. E. Marrs, Consulting Application Engineer, Metal Rolling Application Engineering, General Electric Co., Schenectady, N. Y.

"On-Line Computer Control for a Reversing Plate Mill," by A. W. Smith and L. P. Gripp, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

"Controls and Instrumentation," by W. J. Tunny, Superintendent, Electrical Maintenance, The Youngstown Sheet and Tube Co., East Chicago, Ind.

9:30 am—JOINT IHEA AND AISE SESSION ON CONTINUOUS FURNACE PROCESSING—
Monongahela Room

Chairman: Hugh J. Pugsley, Senior Vice President, Swindell-Dressler Corp., Pittsburgh, Pa.

"Continuous Strip Annealing," by W. P. Gill, Marketing Specialist, Industrial Heating Dept., General Electric Co., Shelbyville, Ind.

"Continuous Heat Treatment of Steel Plate," by N. K. Willis, Director of Engineering, Drever Co., Bethayres, Pa.

"Continuous Galvanizing," by Carroll Cone, Vice President—Engineering, Surface Combustion Div., Midland-Ross Corp., Toledo, Ohio

2:00 pm—OPERATING PRACTICE SESSION—
Urban Room

Chairmen: W. A. Black, Assistant Director of Research, Electromechanical Research Center, Republic Steel Corp., Cleveland, Ohio

A. B. Glossbrenner, General Foreman, The Timken Roller Bearing Co., Canton, Ohio

"Continuous Galvanizing Practices and Trends," by Dean W. Ferguson, General Foreman, Galvanizing, Pittsburgh Works Div., Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Recent Developments in Strip Thickness Control," by I. G. Orellana, Head, Measurement & Control, Electromechanical Research Center, Republic Steel Corp., Cleveland, Ohio

"Strip Processing," by Donald A. McArthur, Vice President—Engineering, The Wean Engineering Co., Inc., Warren, Ohio

2:00 pm—LUBRICATION SESSION—
Monongahela Room

Chairmen: A. E. Cichelli, Lubrication Engineer, Construction Engineering Dept., Bethlehem Steel Co., Bethlehem, Pa.

C. E. S. Eddie, Plant Lubrication Engineer, Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Mich.

"Crane Rail Lubrication," by Elmer E. Fleck, President, and Hugh L. Davis, Sales Engineer, Research Appliance Co., Allison Park, Pa.

"Effect of Fire-Resistant Fluids on Design and Operation of Hydraulic Systems," by William M. Schrey, Field Lubrication Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

"The Selection and Evaluation of Rolling Oils," by R. W. Kenyon, General Sales Manager, Kerns United Corp., Chicago, Ill.

TUESDAY, SEPTEMBER 26

9:00 am—ELECTRICAL SESSION—
Urban Room

Chairmen: Elmer E. Barthel, Assistant Superintendent—Maintenance, Pittsburgh Steel Co., Monessen, Pa.

Clayton L. Squier, Assistant Electrical Superintendent, Bethlehem Steel Co., Lackawanna, N. Y.

"Electrical Protection on High Capacity Systems," by Paul S. Potter, Electrical Engineer, Bussmann Manufacturing Div., McGraw-Edison Co., St. Louis, Mo.

"Application of Circuit Breakers with Symmetrical Ratings in Steel Mills," by Philip L. Camp, Manager, Low Voltage Engineering, I-T-E Circuit Breaker Co., Philadelphia, Pa.

"Electrical Lockout Procedures," by J. R. Lamberton, Electrical Engineer, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

9:00 am—COMBUSTION SESSION—
Monongahela Room

Chairmen: C. W. Dunn, Superintendent Utilities, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

F. C. McGough, Superintendent, Fuel and Power, The Youngstown Sheet and Tube Co., East Chicago, Ind.

"Gas Analysis Applied to Blast Furnaces," by J. F. Triolo, Application Engineer, Iron & Steel Industry Div., Bailey Meter Co., Cynwyd, Pa.

"Computers in Fuel and Utilities Dispatching," by Lee I. Dickinson, Fuel Engineer, Lackawanna Plant, Bethlehem Steel Co., Lackawanna, N. Y.

"Modern Blast Furnace Blowing and Gas Recovery Systems," by C. W. Dunn, Superintendent Utilities, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

2:00 pm—BLAST FURNACE SESSION—
Urban Room

Chairmen: C. A. Roberts, Jr., Chief Engineer, Phoenix Steel Corp., Phoenixville, Pa.

Stephen Vajda, Process Development Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"The Injection of Auxiliary Fuel into the Blast Furnace," by Dr. Julien Raick, Consulting Engineer, Brussels, Belgium

"Natural Gas Injection at Great Lakes Steel Blast Furnaces," by William H. Collison, Plant Superintendent, Blast Furnaces and Coke Works, Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Mich.

"Sintering Fans—Selection and Design Considerations," by Gerald J. Durning, Chief Engineer, The Green Fuel Economizer Co., Inc., Beacon, N. Y.

2:00 pm—ROLLING MILLS SESSION—
Monongahela Room

Chairmen: F. G. Kredel, Chairman Bar Mill Committee, Republic Steel Corp., Cleveland, Ohio

R. P. Schuler, Superintendent, North Mills, Inland Steel Co., East Chicago, Ind.

"Spiral Welded Pipe and Its Future," by L. C. Oertle, Jr., Chief Engineer, The Driam Corp., Manitowoc, Wis.

"Technological Exploitation of the Stretch-Reducing Process," by Dieter Hancke, Vice President—Sales, and Robert Hartenstein, Vice President—Engineering, Mannesmann-Meer, Inc., Youngstown, Ohio

"Design and Performance of Recent Developments in Bar Mill Cooling Beds," by Wm. K. Stamets, Jr., President & General Manager, Northeast Ohio Machine Builders, Inc., Columbiana, Ohio, and J. Ralph Dye, Works Manager, Milton Steel Div., Merritt-Chapman & Scott Corp., Milton, Pa.

WEDNESDAY, SEPTEMBER 27

9:00 am—ELECTRICAL SESSION—
Urban Room

Chairmen: H. W. Dorset, Assistant Superintendent, Electrical Dept., Bethlehem Steel Co., Sparrows Point, Md.

John A. Drgon, Division Superintendent—Maintenance and Utilities, Edgar Thomson Works, United States Steel Corp., Braddock, Pa.

"Motor Heating Effects of Reactor Type Control Systems for A-C Cranes," by J. A. Halvorson, Electrical Engineer, Bridge & Crane Control Section, Cutler-Hammer, Inc., Milwaukee, Wis.

"Something Different in Reactor Crane Control," by C. A. Schurr, Supervisor of Systems Development Section, EC&M Div., Square D Co., Cleveland, Ohio

"The Crane of the Future," by F. M. Blum, General Sales Manager, Industrial Div., Harnischfeger Corp., Milwaukee, Wis.

"The A-C Mill Motor—A New AISE Standard," by Malcolm B. Antrim, Chairman, AISE Mill Motor Committee, and Manager, Engineering and Construction Div., Lukens Steel Co., Coatesville, Pa.

9:00 am—COMBUSTION SESSION—
Monongahela Room

Chairmen: William M. Bloom, Chief Fuel Engineer, General Engineering, Allegheny Ludlum Steel Corp., Pittsburgh, Pa.

A. S. Merrow, Assistant Fuel Engineer, Bethlehem Steel Co., Lackawanna, N. Y.

"Nitrogen from an Air-Separation Plant as a Heat-Treating Atmosphere," by B. Herbert, Metallurgist, and J. R. Rink, Research Metallurgist, Research & Development Dept., Inland Steel Co., East Chicago, Ind., and L. R. Chrzan, Laboratory Div. Head, and M. F. Hoffman, Project Engineer, Development Laboratory, Linde Co., Newark, N. J.

"The New 5-Zone Slab Heating Furnace at Campbell Works, The Youngstown Sheet and Tube Co.," by D. C. Haney, Superintendent, Fuel and Power, Youngstown District, and J. B. Mitchell, Assistant Superintendent, 79-In. Hot Strip Mill, Campbell Works, The Youngstown Sheet and Tube Co., Youngstown, Ohio

"New Pits at Acme-Newport Steel Co.," by R. R. Kuhni, Combustion Engineer, Acme-Newport Steel Co., Newport, Ky.

2:00 pm—MECHANICAL SESSION—
Urban Room

Chairmen: L. A. Fugassi, Chief Engineer, Midwest Steel Co., Div. of National Steel Corp., Valparaiso, Ind.

S. W. Stouffer, Director of Construction and Maintenance, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"Welding—A Versatile and Economical Tool in Steel Mill Maintenance," by J. J. Matusek, Assistant Superintendent, Mechanical Dept., Inland Steel Co., East Chicago, Ind.

"Steel Mill Service Water Studies," by R. H. Anderson, Head, Cleveland Dept., Stanley Engineering Co., Cleveland, Ohio, and K. A. Roddy, Report Group, Stanley Engineering Co., Muscatine, Iowa

"Design Considerations for Belt-Conveyor Systems," by H. Colijn, Senior Technologist, Electromechanical Research, Applied Research Laboratory, United States Steel Corp., Monroeville, Pa.

2:00 pm—OPERATING PRACTICE SESSION—
Monongahela Room

Chairmen: Frank F. Argust, Superintendent, Industrial Engineering, The Colorado Fuel and Iron Corp., Pueblo, Colo.

H. F. Miller, Assistant General Manager, Bethlehem Steel Co., Bethlehem, Pa.

"Capital Investment and Productivity Measurement," by Wm. T. Hogan, S.J., Professor of Economics and Director, Industrial Economics Program, Fordham University, New York, N. Y.

"The Changing Open Hearth," by Edgar B. Speer, Administrative Vice President, Central Operations—Steel, United States Steel Corp., Pittsburgh, Pa.

"Noise Control in the Steel Industry," by James H. Botsford, Noise Control Engineer, Bethlehem Steel Co., Bethlehem, Pa.

7:00 pm—FORMAL DINNER—Ball Room

10:00 pm—DANCE—Urban Room

AISE members and guests. No admission charge.

THURSDAY, SEPTEMBER 28

8:30 am—INSPECTION TRIP—

Armco Steel Corp., Butler, Pa. Buses leave from Penn-Sheraton Hotel.

Electric Furnace or Cupola Basic Oxygen Converter For The Nonintegrated Steel Plant

by D. A. SUTCH
President
and H. C. MANLEY
Metallurgical Engineer
Ramseyer and Miller, Inc.
New York, N. Y.

. . . . the expected rate of operations, desired flexibility, operational cost, quality of raw materials, product range and the ability to integrate existing facilities are factors to be investigated in the consideration of expansion of steelmaking facilities for either a semi- or nonintegrated steel plant . . . .

THE basic oxygen steelmaking process has attracted widespread interest since its commercial introduction about eight years ago. The capital investment costs, the metallurgical control, the operational technique and the over-all economics of the process have been the subjects of many technical papers.[1,2,3]* Other authors[4,5] have examined the quality of basic oxygen steel and found it to be comparable to that from the open hearth. An economic study[6] that examined total ingot costs by the open hearth and basic oxygen processes has indicated that whereas the unit net metal cost of the oxygen converter is nearly the same as that of the open hearth, the costs above or conversion expenses of the basic oxygen process are lower than those of the open hearth. However, in this work, hot metal was priced at about $7.00 per ton less than scrap.

In general, the discussions of basic oxygen operations have considered its use in conjunction with already existent blast furnace facilities. Although there may be other installations that are not connected with ore reduction furnaces, there are but two known installations where basic oxygen operations were conceived with the employment of a high percentage of scrap metal. In early 1958 Gusstahlwerk Witten A.G. in Germany installed a 30-ton detachable bottom oxygen converter that was fed from a scrap-melting, hot blast cupola. In the following year Acme Steel Co. began a similar operation which was described in the March 1960 *Iron and Steel Engineer*.[7] Recently Van Voris and Crane[8] have examined the potentiality of the basic oxygen furnace coupled with a cupola for steel foundry purposes.

This work departs from most of the previous studies in that it explores the economic aspects of ingot making as applicable to nonintegrated steel plants. The semi-integrated producers, who do not have a blast furnace as a hot metal source, usually make their steel by the all cold metal practice in either open hearth or electric furnaces. The cost of producing ingots by the all cold metal practice is usually higher than the hot metal scrap meltshop practice of the integrated steel plants so that any possible reduction of ingot costs is of extreme importance to the semi-integrated plants. With the full commercial recognition of the basic oxygen furnace, the semi-integrated producer now has another available process to consider when expanding his present ingot-making capacity or when establishing a new semi-integrated meltshop.

Previous to the development of the basic oxygen process the semi- or nonintegrated producers had the choice of using either the electric arc or open hearth furnaces with a cold charge operation, although in a few cases cupolas were installed to supply cupola metal which was substituted for a portion of the normal all cold furnace charge. Since the end of World War II there has been a definite tendency toward the use of electric arc furnaces for newly installed cold charge melting facilities, and even in the replacement of open hearth facilities. If the open hearth is to be considered obsolescent for cold charge practice, the nonintegrated producer then has the choice of making ingots by either the electric furnace or the basic oxygen process. However, the basic oxygen furnace cannot use an all cold charge so that hot metal facilities are required in addition to the steelmaking equipment.

A blast furnace installation sufficiently large to produce the hot metal required for the production of 250,000 tons of ingots per year by the oxygen converter process would cost from $20,000,000 to perhaps $30,000,000, the total cost depending upon what auxiliary facilities were necessary. In addition to this relatively large sum of money for the equipment installation, a much larger expenditure would be required to insure the availability of raw materials at prices that would allow the production of hot metal at a cost approaching $33.00 per net ton as used by Rueckel & Irvin.[6]

Since the establishment of a blast furnace operation is a major expenditure for even the fully integrated com-

* Numbers in parentheses refer to Bibliography at end of article.

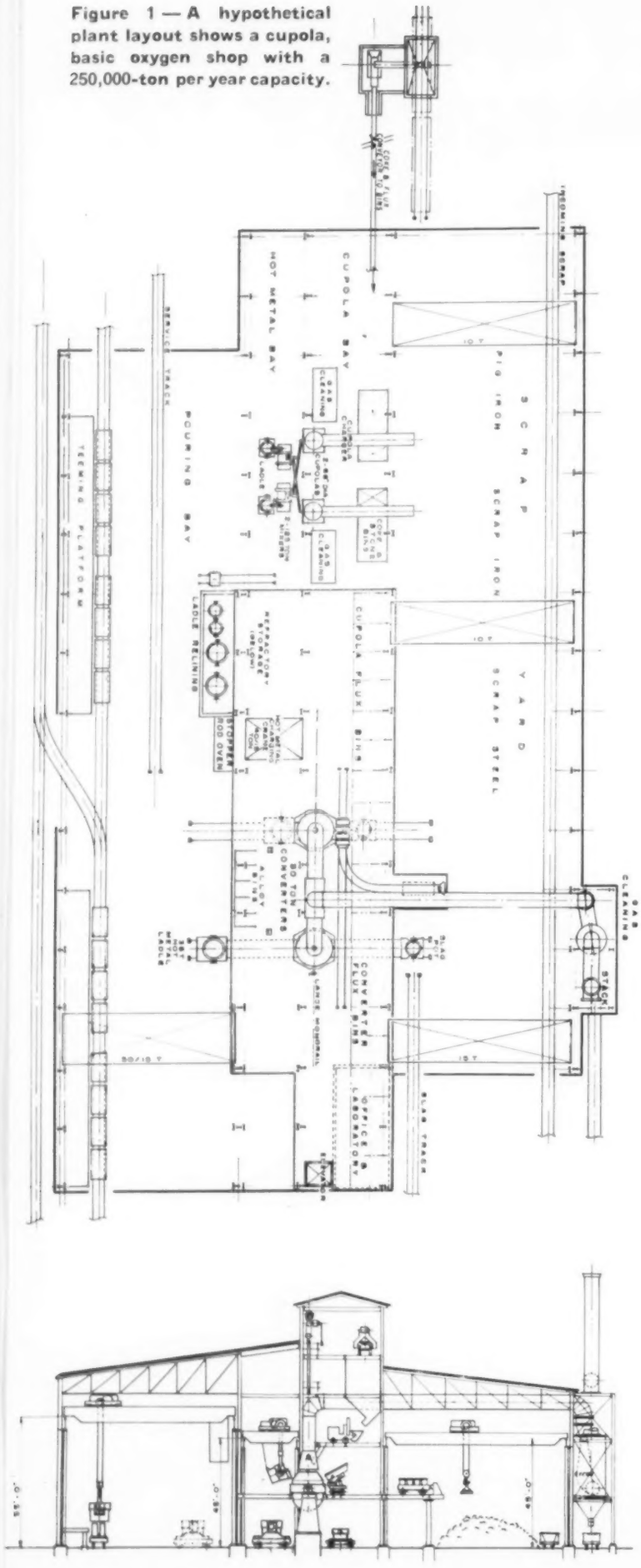


Figure 1 — A hypothetical plant layout shows a cupola, basic oxygen shop with a 250,000-ton per year capacity.

panies, it appears necessary and logical, for the smaller semi- or nonintegrated producers that are considering the basic oxygen process, to explore sources other than the blast furnace for hot metal requirements. The cupola has been recognized as a relatively efficient melting unit for many years. Thus the hot blast basic cupola, with its relatively low capital costs, would seem most suited for producing the hot metal that is required by the basic oxygen furnace. In contrast to the $20,000,000 minimum required for a blast furnace installation, the cost of a cupola and all of the necessary auxiliary equipment for the production of 250,000 annual tons of basic oxygen ingots is somewhat less than $2,000,000. Thus the nonintegrated producer, from an investment point of view, can advantageously utilize a hot blast cupola installation to obtain the hot metal that is required for a basic oxygen steelmaking installation.

In order to examine comparatively these two ingot-making processes for semi-integrated plants, three plant locations (Pittsburgh, Philadelphia and Portland, Ore.) were selected because the individual areas have various influences on the costs of producing ingots by the two different processes. Plants of 100,000, 250,000 and 500,000-ingot ton capacity were selected as the 100,000 to 500,000-ton range includes most of the nonintegrated carbon steel producers. In addition, it is generally felt that carbon steel plants larger than 500,000 tons should be examined from both a non-integrated and integrated point of view.

In order to properly develop the capital and ingot production costs of the various plants, it was necessary to make a general plant layout at each of the three tonnage levels for both the electric furnace and the cupola, basic oxygen shops. Initially, plant layouts for the 250,000-ingot ton electric furnace and cupola, basic oxygen plants were made and these were later adjusted to the operating requirements of the other tonnage levels. Carbon steel products consisting of rod and bar mill items, plates and structurals, which are consistent with the usual product mix of most semi-integrated producers, were assumed.

The tap-to-tap time for electric furnace practice was adjusted in accordance with their size, while that of the basic oxygen was kept constant at one hr. The 1-hr heat time rather than the conventional 45-min heat time for the oxygen converter, has been chosen because of the intermediate carbon requirements of the products selected.

The desired mechanics of analysis control for the manufacture of higher carbons in the basic oxygen furnace are not yet a matter of full agreement, but the practice of stopping the blow (one or more times), running a preliminary analysis and using the preliminary analysis to make adjustments to operations has proved fully successful. However, such practice can result in an up to 50 per cent increase in the time for making the heat. In relation to "catch carbon" practice, Kurzinski[9] states that the "oxidation reactions in the L-D converter are completely predictable. Thus it is possible to catch carbon by taking into consideration the chemistry and the weight of the charge and the duration and the rate of the oxygen blow." This is somewhat opposed to the 1958 finding of Cuscoleca and Rosner[3]: "the lack of a measuring

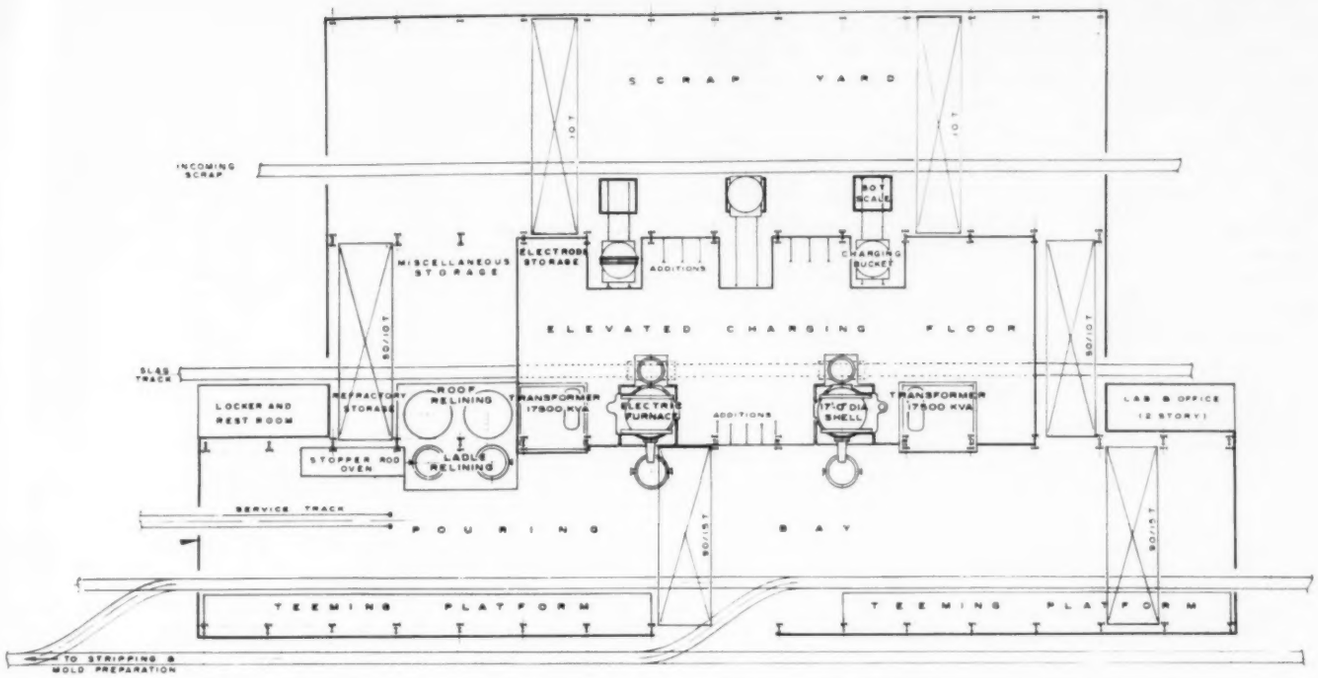


Figure 2 — A hypothetical plant layout shows electric furnace shop designed for 250,000-ton per year capacity.

device for the progress of refining reactions." In all probability a measuring device of the desired accuracy, which might have to consider not only carbon and oxygen but phosphorus, manganese and sulphur plus temperature, slag condition and possible lack of chemical equilibrium, is still in the future so that higher carbon steels will probably be made by the preliminary sampling technique for some time.

The plant layout for the 250,000-ton cupola, basic oxygen shop is shown in Figure 1. This is a 2-level shop consisting of ground-level metal-mixing-and-pouring facilities and a scrapyard, and an elevated cupola and basic oxygen furnace bay. Stripping, mold preparation, skullcracking and the oxygen plant are separate facilities. The plant design contemplates the ample use of conveyors and storage bins to minimize the materials-handling problems associated with the basic oxygen furnace. Two unlined stack, 66-in. shell diameter, hot blast cupolas provide a continuous supply of hot metal to two 30-ton basic oxygen vessels. The general plant layout of both the lowest and highest tonnage shops have been modified only in regard to the building dimensions and the size of the process equipment. One 66-in. cupola and two 12-ton basic oxygen furnaces were used at the lowest tonnage level (100,000 tons) and two 102-in. cupolas and two 60-ton basic oxygen furnaces at the highest tonnage level (500,000 tons). A vertical section through the 250,000-ton cupola, basic oxygen shop is illustrated in Figure 1.

The plant layout of the electric furnace shop at the 250,000-ton level is presented in Figure 2. This layout, as the one for the cupola, basic oxygen shop, does not represent any existing plant. It is a typical 3-bay, 2-level shop, consisting of a scrap yard, the 2-level furnace bay containing two 17-ft shell diameter, 55-ton furnaces with 17,500-kva transformers and a pouring bay. Not shown in the plant layout are separate mold-stripping-and-preparation and skullcracking facilities which are included in the capital cost estimate. It should be noted that the design of the electric furnace meltshop changes quite markedly above the 100,000-ton per year level. It changes from a 1-bay, 1-level shop to a 3-bay, 2-level shop. This change is both economical and practical at production levels above 100,000 tons.

The plant layout of the largest (500,000 ton) electric furnace shop is very similar to that of the 250,000-ton level, with three 19-ft shell diameter, 90-ton furnaces as the basic equipment. The plant layout foreseen for the 100,000-ton electric furnace shop is a 1-bay single-level shop, having a straight line material flow from scrap receiving through ingot stripping. A portion of the pouring area in this low tonnage shop, which uses two 11-ft shell diameter, 15-ton furnaces, is utilized for stripping and mold preparation. Average ingot sizes of 8 in. (900 lb), 13 in. (2100 lb) and 16 in. (3200 lb) respectively, were assumed for the three size plants. The number and size of the arc furnaces in these shops are considered as an average installation but other combinations might be more advantageous in actual individual installations.

Both types of steelmaking plants are equipped with gas cleaning units capable of satisfying most air pollution codes.

CAPITAL COST ESTIMATE

A tabulation of the estimated erected costs for these plants is given in Table I.

The building costs (Table I) include foundations and complete erection but no site preparation. The cost of utilities includes the water, sewer, air, electrical and oxygen systems but assumes that electrical energy, water and a railroad line are available close to the plant site. No provision was made in the electric furnace meltshops for synchronous condensers or reactors since their need or value cannot be generalized because of different possible plant locations or different electrical energy rate schedules. The miscellaneous items consist of meltshop office, locker room, laboratory and equipment, yard equipment, trackage and miscellaneous tools. The cost of the erected plant is based

TABLE I
Capital Cost Estimate

Tonnage level	100,000		250,000		500,000	
Process	Two 15-ton, 11-ft diam electric furnaces	One 66-in. cupola and two 12-ton converters	Two 55-ton, 17-ft diam electric furnaces	Two 66-in. cupolas and two 30-ton converters	Three 90-ton, 19 ft diam electric furnaces	Two 102-in. cupolas and two 60-ton converters
Buildings	$ 540,000	$ 622,500	$1,599,000	$1,143,500	$2,600,000	$1,689,800
Utilities	118,800	135,300	377,500	255,700	610,000	382,800
Cranes	275,000	275,000	1,221,000	676,500	1,881,000	940,400
Furnace and auxiliaries	620,000	954,500	1,530,000	1,553,500	2,837,500	2,329,500
Charging and pouring	125,200	382,500	491,000	872,000	845,000	1,451,000
Scrap material handling	60,000	370,500	229,000	605,500	343,500	836,500
Mold preparation and stripping	77,000	66,000	781,000	781,000	1,158,500	1,158,500
Electrical equipment	146,000	289,000	360,000	476,000	550,000	684,000
Skull cracker	...	...	229,000	229,000	342,500	342,500
Oxygen plant	...	700,000	...	1,200,000	...	1,900,000
Miscellaneous	128,400	113,500	323,000	307,500	384,000	363,000
Engineering, supervision, and contingencies	209,600	391,200	715,500	809,800	1,148,000	1,196,000
Total	$2,300,000	$4,300,000	$7,856,000	$8,910,000	$12,700,000	$13,274,000
Cost per ton of ingot capacity	$23.00	$43.00	$31.40	$35.60	$25.40	$26.50
Financial charge at 12 per cent per annum	$276,000	$516,000	$942,000	$1,068,000	$1,523,000	$1,594,000
Financial charge per ton of capacity	$2.76	$5.16	$3.77	$4.27	$3.05	$3.19

upon information furnished by various suppliers, from company files and from updated records of other plants which in most cases were modified to adjust costs for plant capacity.

As the same methods were used in developing the capital costs for both types of installation, it is reasonable to assume that the relationship of the costs for the two types of plants should be quite accurate. The capital cost advantage of the electric furnace shop, as reflected by the cost per ingot ton of capacity, is quite substantial at the 100,000-ton level, markedly smaller at the 250,000-ton level, and practically nonexistent at the 500,000-ton level. There is one thought that should be added at this point. The cupola, basic oxygen shops undoubtedly have greater reserve or maximum ultimate capacities than the electric furnace shops. Under pressing demand, basic oxygen production could be increased to 120 per cent of the nominal rating given herein. The electric furnace shops are not considered to have the same margin of reserve capacity. On the other hand, it appears that the greater flexibility of the electric furnace shop on startup and shutdown offers a distinct advantage for scheduling heats, particularly during periods of relatively poor business conditions.

It should be noted that the capital cost comparison is based upon specific equipment. If the 250,000-ton electric furnace shop were fitted with three 35-ton furnaces, rather than two of 50 tons, which might be desirable under certain operating conditions, the capital cost of the 250,000-ton electric furnace shop would show a slight decrease. Conversely the "Cost Above" of ingots produced in the three 35-ton furnaces would be greater than that of the two 50-ton units. It thus follows that Table I may serve as a general comparison of the relative investments for the two types of plants, but each contemplated meltshop should be separately analyzed to consider the matter of required scheduling, flexibility, etc., that may be required.

While a capital cost comparison presents one aspect of the information needed to decide which type of shop may be preferable, the total ingot costs, including net metal, conversion cost above metal and fixed charges on the capital investment per ton of ingots, is the item of ultimate economic concern.

Arriving at a net metal cost is a difficult problem since the cost of almost all of the metal charge used in nonintegrated steelmaking is continually changing. Also, there is a great difference of opinion among operators and metallurgists as to what may constitute an acceptable metal charge.

Average 1959 trade journal prices for pig iron and scrap were used for the determination of the net metal cost for both the electric furnace and the cupola basic oxygen processes. The price of revert scrap was assumed to be the same as that of the No. 1 heavy melting steel scrap. The electric furnace charge used herein approximates an average of known electric furnace practices (on the products assumed) but it must be recognized that the relative percentages of No. 1 and No. 2 scrap bundles, etc., are varied to a great degree in different shops and even over a period of time in the same shop. Also, it is known that product requirements, local price differentials between grades of scrap and differences in quality in the same grade of scrap in various parts of the country influence the make-up of individual plant metal charges. It is obvious that an increase in the percentage of No. 2 bundles will exert a strong influence on the metal cost. However, the plant's equipment may limit the percentage usage of this grade of scrap. Thus the individual operator, with either steelmaking process, must consider his operational problems, metallurgical requirements and yield loss on melting to arrive at the most economical use of No. 2 bundles and possibly in some locations No. 2 heavy melting scrap.

Although the electric furnace operator would be expected to use quite limited quantities of No. 2 bundles in the 100,000-ton operation and greater quantities in the 500,000-ton plants, for the sake of uniformity the same metallic charge has been used for all three sizes of electric furnace plants. Bundles were not considered compatible to good operation in the 66-in. cupolas; therefore, they were not used in the 100,000 and 250,000-ton cupola, basic oxygen plants. The 500,000-ton plant assumes the use of approximately 20 per cent No. 2

TABLE II
Net Metal Cost—Electric Furnace Ingot

Material	Weight, lb	Material cost per net ton	Cost per net ingot ton
Revert scrap	301	$38.80	$ 5.84
No. 1 heavy melting	200	38.80	3.88
No. 2 heavy melting	1104	32.85	18.15
No. 2 bundles	400	27.15	5.44
Scrap molds and stools	50	45.00	1.13
Additions	72	Various	2.49
	2123		$36.93
Scrap credit, pit, short ingots and skulls	40	38.80	0.78
Net total			$36.15

bundles as in the electric furnace operations.

The metal charge for the electric furnace plants consists of roughly 15 per cent revert or home scrap, 9 per cent No. 1 heavy melting, 52 per cent No. 2 heavy melting and 19 per cent No. 2 bundles. A charge to ingot yield of 92, 94 and 95 per cent has been used for the respective electric furnace shops, which figures are felt to be reasonable. With such a charge, the net metal cost per ton of ingots for the 250,000-ton Pittsburgh area plant would develop as in Table II.

In developing the net metal cost per ingot ton for the cupola, basic oxygen shop, it is convenient to divide the costs into those associated with the cupola operation and those of the basic oxygen furnace. The reasonable assumption that the temperature and composition of the cupola metal is such that about 15 per cent scrap will be charged in the oxygen converter has been made. Cupola metal approximating 4 per cent carbon, 0.50 per cent silicon, 0.25 per cent manganese, 0.10 per cent phosphorus and 0.04 per cent sulphur and having a tapping temperature in the vicinity of 2700 F would satisfy this condition. A yield of 88 per cent has been assumed from cupola charge to ingot, developed as 100 per cent for the cupola operation and 88 per cent for the basic oxygen operation. The aim analysis should be met with a cupola charge consisting of roughly 75 per cent No. 2 scrap, 10 per cent malleable pig iron and 15 per cent cast-iron scrap which includes the plant's mold and stool scrap. Although other charge mixes could have been chosen, it is believed that this one is reasonably representative for developing expected metal costs. As discussed under the electric furnace charge materials, other cupola charges which might consist of up to 100 per cent of the cheaper grades of scrap, including turnings, would result in apparently lower metal costs, but one cannot plan on such practices without anticipating additional and/or different operating problems and practices together with their associated costs. The above metal charge would give a net metal cost per ton of cupola, basic oxygen ingots in the Pittsburgh area at an annual tonnage level of 100,000 and 250,000 as in Table III.

TABLE III
Net Metal Cost—Cupola, Basic Oxygen Ingot

Cupola material	Weight, lb	Material cost per net ton	Cost per net ingot ton
No. 2 heavy melting	1448	$32.85	$23.78
Malleable pig iron	193	59.40	5.73
Molds and stools	50	45.00	1.13
Scrap iron, No. 1 cupola	239	42.20	5.04
	1930		$35.68
Scrap credit, spills and skulls	20	42.20	0.42
Net total			$35.26

Oxygen converter material	Weight, lb	Material cost per net ton	Cost per net ingot ton
Cupola hot metal	1910		$35.26
Revert scrap	320	$38.80	6.21
No. 2 heavy melting	20	32.85	.33
Ferroalloys	22	187.50	2.06
	2290		$43.86
Scrap credit	40	38.80	0.78
Flue dust credit	20	17.30	0.17
Net total			$42.91

A comparison of the net metal cost of the cupola, basic oxygen shop to that of the electric furnace shop indicates that the net metal cost for the electric furnace is substantially less than that for the cupola basic oxygen at the 250,000-ton level. The difference results principally from two factors. The first factor is the six per cent greater yield in the electric furnace ingot-making practice, while the second factor is the difference in the charge make-up. A limited amount of No. 2 bundles is used in the electric furnace operation, while none are used in the 100,000 and 250,000-ton cupola, basic oxygen shops, since it is not felt to be practical to charge the usual No. 2 bundle in a 66-in. cupola. The metal cost differential due to the use of No. 2 bundled scrap is removed for the highest tonnage plant by the same percentage use of this item as in the electric furnaces. The other item of cost difference in the charge make-up is the use of relatively high-priced pig iron and purchased iron scrap in the cupola, basic oxygen process.

There are two situations that might diminish or fully cancel the higher metal costs of the cupola, basic oxygen shop. In some localities scrap ingot molds are available at prices lower than No. 1 cupola cast scrap which in turn is much lower than malleable pig iron. In such a situation the mold scrap could be substituted for both the pig iron and the cupola cast. In other localities "mixed agricultual scrap," a mixture of iron and steel and malleable scrap is available and could be used to replace the higher priced pig iron and No. 1 cupola scrap. Automotive motor block scrap is also available on the open market, but the use of this material cannot be planned on a general basis since in many localities the residual elements from all steel scrap charges, are already higher than many people consider desirable or are acceptable under some specifications.

Another possibility is the use of an all steel scrap charge in the cupola, as practiced at Gustahlwerk Witten A. G. Their practice, however, uses higher coke rates than planned herein and results in an excess of revert steel scrap which in Witten's case is cold charged in electric arc furnaces. The revert scrap could be charged into the cupola furnace.

In addition to "cost of metal" there are two other major expense items to be considered. One of these, cost above net metal, is discussed next. Electric furnace steel for the end products described earlier is usually

TABLE IV

The Effect of Tonnage Level on the Total Ingot Costs in the Pittsburgh Area

Tonnage level	100,000		250,000		500,000	
Process	Electric furnace	Cupola, basic oxygen	Electric furnace	Cupola, basic oxygen	Electric furnace	Cupola, basic oxygen
Net metal	$36.75	$42.91	$36.15	$42.91	$35.67	$41.70
Cost above	34.41	32.43	26.19	25.18	21.45	20.18
Fixed charges	2.76	5.16	3.77	4.27	3.05	3.19
Total ingot cost	$73.92	$80.50	$66.11	$72.36	$60.17	$65.07

TABLE V

The Effect of Location on the Total Ingot Costs at Production Level of 250,000 Tons Per Year

Location	Pittsburgh		Philadelphia		Portland, Ore.	
Process	Electric furnace	Cupola, basic oxygen	Electric furnace	Cupola, basic oxygen	Electric furnace	Cupola, basic oxygen
Net metal	$36.15	$42.91	$31.97	$39.21	$32.76	$40.95
Cost above	26.19	25.18	26.92	25.74	23.18	32.76
Fixed charges	3.77	4.27	3.77	4.27	3.77	4.27
Total ingot costs	$66.11	$72.36	$62.66	$69.22	$59.71	$77.98

made by single slag practice so that the tap-to-tap heat times of these furnaces was planned accordingly. The 1-hour heat time set for the basic oxygen furnace has been previously discussed, but the possibility of making certain products by ladle recarburizing fully blown steel, with a decrease in labor expense, must be recognized.

The cost of power, fuel, fluxes, refractories, etc., were established from current schedules and prices. Labor cost has been based on steel industry wage classification rates plus 25 per cent average incentive plus an additional 30 per cent for insurance, holidays and fringe benefits. Unit consumption of fuel, materials, etc., have been taken, to a large extent, from actual operating records. One half of the semi-integrated plant's general overhead expense: the costs of plant protection, building maintenance, plant central office, in-plant transportation, etc., are also included in the ingot manufacturing Costs Above. The operating costs are those expected after the plant operation has been established. No allowance has been made for the extra costs that would be incurred during the startup and shake-down period. The extra expense connected with startup would probably be less in the electric furnace shop for there is a greater reserve of experienced operators and practice data for this type of operation. In addition the basic oxygen plant must have two operations: the cupola and the converter.

With this method of procedure the relative Costs Above for the 250,000-ton Pittsburgh plants developed as:

Electric furnace shop. . . . . $26.19 per ton of ingot
Cupola, basic oxygen shop. $25.74 per ton of ingot

The last item of expense is that for financial charges. This expense for interest and depreciation has been charged at a flat 12 per cent (Table I) of the total capital costs. As the capital costs of the 250,000-ton electric furnace and cupola, basic oxygen shops were $7,856,000 and $8,910,000 respectively, the respective capital charges for these two shops are $3.77 and $4.27 per ton of ingot.

Similar calculations were made for the 100,000 and 500,000-ton plants in Pittsburgh; the 250,000-ton plants in Philadelphia where both coke and electricity are more expensive; and the 250,000-ton plants in Portland, Ore., where coke is relatively expensive and electrical power is relatively cheap.

The resultant ingot costs for these various conditions are indicated in Tables IV and V. The data have also been charted, see Figures 3 and 4.

Tables IV and V give differences in financial and ingot costs for different size plants at different locations but one must keep in mind the specific conditions which were established before developing the costs that are given in these tables.

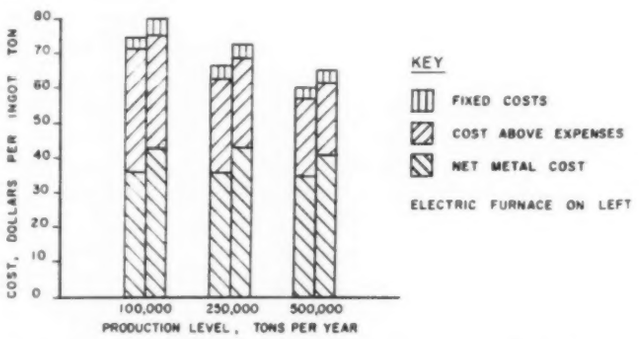
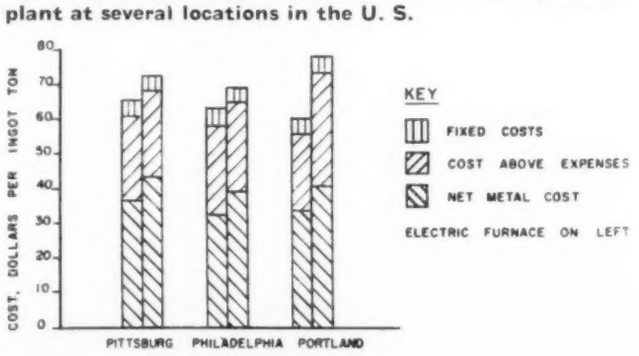


Figure 3 — A cost comparison of the electric furnace vs the cupola, basic oxygen plants were made at several production levels in the Pittsburgh area.

Figure 4 — Cost comparison of the electric furnace vs the cupola, basic oxygen plant were made for 250,000-ton plant at several locations in the U. S.



At the 100,000-ton level one can expect the electric furnace plant to be the most economical ingot-making facility. Even though the Pittsburgh cupola, basic oxygen plant shows a lower Cost Above, it does not appear very probable that the basic oxygen metal cost could be reduced sufficiently to make up for the indicated difference of $8.50 per ton between the metal and financial costs of the two types of plants.

The last group of figures in Table IV are the ingot costs developed for a 500,000-ton plant located in Pittsburgh. At this level the capital cost advantage of the electric arc furnace plant is practically nonexistent and the cupola, basic oxygen would actually be cheaper if based on true ultimate capacity. In addition, the costs above are favorable to the cupola, basic oxygen process by about a 5 per cent margin. Therefore, if some of the metal cost handicap could be overcome, the cupola, basic oxygen plant would become more attractive than the electric furnace shop at this location for the 500,000-ton size of plant.

Directing attention to Table V, the two processes have fairly equal cost above the financial charges at the 250,000-ton level in the two Pennsylvania plants while the cost of metal makes the electric furnace more economical. Pittsburgh is one of the locations where ingot mold and stool scrap is normally available. If this type of scrap were used to replace all or part of the pig iron and purchased cupola cast scrap, the two processes could conceivably produce ingots at approximately the same cost. The 250,000-ton plants in Philadelphia reflect slightly increased costs above principally due to slightly higher prices for electric power and coke. The lower price of steel scrap in Philadelphia accounts for the lower total ingot cost at that point. In Portland the ingot costs for the two 250,000-ton plants reflect scrap prices approximately equal to those of Philadelphia but with electric power prices less than half of either Philadelphia or Pittsburgh and foundry coke and pig-iron prices well above those of the two Pennsylvania locations. Even if scrap were substituted for pig iron at Portland, it is difficult to foresee the cupola, basic oxygen plant being the most economical installation.

Since each of the two processes could be the more economically advantageous as a result of local conditions one cannot make the general statement that either one produces the lower cost ingot. Each contemplated meltshop should be separately analyzed in regard to the costs of electric power, coke, iron and steel scrap, metallurgical requirements of the finished products and operational flexibility determining which of the two processes should be utilized. In effect this procedure replaces some of the assumptions, that were necessary for this comparison, with actual facts and conditions.

It appears that a cupola, basic oxygen installation should be an economical means of expansion for some of the present electric furnace shops that are making a greater variety of products than those assumed for this study. Many of the electric furnace shops make everything from open hearth quality carbon to the high alloy and stainless grades of steel. There would appear to be substantial merit in using the cupola, basic oxygen process for the expansion of such an electric furnace shop. It would then be possible to make many of the straight carbon and low alloy grades of steel by the cupola, basic oxygen practice; while at the same time duplexing basic oxygen steel through the electric arc furnaces to make the higher alloy grades. Such practice would reduce the steelmaking load on the electric furnaces. At the same time duplexing could increase the present capacity of the electric furnaces by removing the meltdown portion of their heat time for many of the higher quality, higher alloy heats. Experience in certain shops has proved that some higher quality grades of steel are consistently more metallurgically desirable when made by finishing blown metal in an electric furnace. Thus the additional factor of quality improvement should merit consideration in any expansion of specialty electric furnace shops.

SUMMARY

This study compares the total ingot costs of an electric furnace plant with those of a cupola, basic oxygen shop at production levels of 100,000, 250,000 and 500,000 tons of ingots per year in Pittsburgh, and of plants capable of producing 250,000 tons of ingots per year in Philadelphia and Portland, Ore.

The capital cost estimate of the plants for these two processes indicated that the capital cost of the electric furnace shop is decidedly lower than that of the basic oxygen shop at a capacity of 100,000 tons per year, definitely lower at 250,000 tons per year and relatively equal at 500,000 tons per year, see Table I. It should be noted that the cost per ingot ton of capacity of the cupola, basic oxygen process decreases continuously with increasing shop size, because shop design features are almost the same for all tonnage levels.

Total ingot costs including net metal cost, costs above metal and fixed charges are significantly lower for the electric furnace shop at production levels from 100,000 to 500,000 tons per year in the Pittsburgh area, see Table IV. This competitive advantage of the electric furnace shop increases somewhat in the Philadelphia location, and is markedly greater in the vicinity of Portland.

This study should not be employed as the sole basis for selecting one process over the other. Specific factors such as expected rate of capacity operations, desired operational flexibility, cost of electric power, coke and scrap, the quality of the available scrap and the product mix, may exert a decisive influence on the proper selection of the most suitable process for a particular steel plant operation.

BIBLIOGRAPHY

1. "The L-D Process in Austria," by B. Matuschka, Journal of Metals, June, 1956.
2. "Oxygen Steel Produced at Dofasco Can Compete with Open Hearth," by McMulkin, Journal of Metals, April, 1955.
3. "L-D Produces Alloy Steels in Austria," by Cuscoleca and Rosner, Journal of Metals, October, 1958.
4. "Properties of Steels Produced by the L-D Process," by Hauttmann, Bulletin of the Research Institute of the Vereinigte Osterreichisce Eisen und Stahlwerke, August, 1953.
5. "Extension of the L-D Process," by Cuscoleca and Rosner, Iron and Coal Trades Review, August 22, 1958.
6. "Economic Aspects of the Oxygen Convertor," by W. C. Rueckel and J. W. Irvin, 1954 AISE Proceedings, p. 163.
7. "Acme Steel Company," by T. J. Ess, 1960 AISE Proceedings, p. 197.
8. "Basic Oxygen Steelmaking—Its Possible Future in the Steel Foundry," by Van Voris and Crane.
9. "Oxygen and Steelmaking Processes," by E. F. Kurzinski, 1960 AISE Proceedings, p. 97. ▲

Cupola Metal Increases Open Hearth Production

By addition of cupola metal, operation of a cold charge shop can be greatly improved either on a tons per hr or a tap-to-tap evaluation

by WILT H. STEINHEIDER
General Foreman
Open Hearth Dept.
Sheffield Div.
Armco Steel Corp.
Kansas City, Mo.

IN 1938, when it became desirable to produce more ingot tons in a 4-furnace open hearth shop, two cupolas were installed to supply hot metal. With an addition of 42 per cent cupola metal to the open hearth furnaces, an increase of about 50 per cent production over that obtained by cold charge operation was secured, i.e., cold charge operation production was at the rate of 11 tons per hr compared to 16.5 tons per hr hot charge operation. These cupolas operated with few interruptions till July, 1957, and were reactivated in November, 1958.

The cupolas have 108-in. shell diameters, are bricked to 72-in. diameters in the well and melting zone and 84-in. diameters above the melting zone. The distance from the bottom to the charging sill is 25 ft. The upper stack is 40-ft high with a cyclone type cinder collector in the top portion. The sand bottom is made up with ten parts silica sand and 1½ parts of fireclay. New clay brick or clay blocks are used for lining below the tuyères, used square clay brick or square silica brick are used for the tuyères, used silica roof brick are used for the next five ft which represents the melting zone and clay blocks are used for the rest of the lining of the stack. High silica mud is used to fill voids. Each cupola has 16 tuyères, 4-in. wide and 4½-in. high.

The cupolas are tapped continuously and a slag trap in the runner discharges the slag into an inclined trough through which water is running. The water granulates the siliceous slag, permitting easy removal. This slag is approximately 48 per cent SiO_2, 6 per cent Al_2O_3, 4 per cent FeO, 6 per cent MnO and 37 per cent CaO. The metal runs into a 150-ton tilting holding ladle, lined with high alumina brick and high alumina plastic. This holding ladle has a lining life of approximately four months. When repairs to the holding ladle are necessary, the metal is run directly into transfer ladles. Under normal operations, the metal is removed from the tilting holding ladle into 35-ton transfer ladles through a teakettle spout. Gas firing is done over the metal in the holding ladle to maintain the temperature of the refractories.

Spray water cooling the outside of the shell at the melting zone and a built-in breast cooler at the taphole are the only cooling methods used on the cupolas. The cupola lining life is 55 to 60 hr, producing 1200 to 1400 tons of metal per lining.

The cupolas are charged by skip hoists using 30-in. gage buggies. Charges are loaded with a magnet into the buggies and weighed on track scales located in the front of each skip hoist. A transfer car is used to transfer charging buggies from the skip hoist to the scale tracks, and to a coke track. The cupolas can be charged with a metallic charge of almost all steel scrap or cast and pig iron under different operating conditions, but the normal charge consists of 40 per cent cast and pig iron and 60 per cent steel scrap. To maintain an even distribution of the components of the charge in the cupola, the loading of the buggies is controlled so that the cast scrap and pig iron is loaded on the bottom, coke and limestone in the middle and steel scrap on the top in one buggy, while in the next buggy the steel scrap is placed on the bottom with the cast scrap and pig iron on top.

In starting a new cupola, coke is placed in the cupola to 44 in. above the tuyères. Eight gas burners, which are flush with the sand bottom, are used to ignite the coke. When the coke at the tuyères is well lit, the gas is shut off, the lighter holes are rammed with sand and the coke is left to burn with a natural draft until the bed is cherry red. The tuyère flaps are then closed, the bed is brought up to 56 in. above the tuyères and 200 lb of limestone is added. The charging

of metallics is then started with the first three charges all pig iron or cast scrap, the next few charges are one half pig iron or cast scrap and one half steel scrap and the rest of the charges (600 to 700) are basically two steel scrap and one pig iron or cast scrap.

In starting the cupola, 6500 cfm of air at a pressure of 10 to 12 oz is used for the meltdown. The air input is kept low during this stage of the operation to reduce blowing taps. After tap, the air is increased to 10,000 to 11,000 cfm. Wind box pressure increased to 22 to 25 oz and it is gradually reduced to 10 oz at the end of the run.

During the first six months of 1959, production averaged 23 tons per hr, coke ratio was 6.5 to 1 and the charge was 60 per cent steel scrap, 15 per cent low silicon pig iron and 25 per cent cast scrap. A flux of 50 lb of limestone per ton of metal produced is used. Some silicon is necessary to maintain desirable silicon in the hot metal, especially during the latter hours of the cupola operation when oxidation increases, and 10 lb of 50 per cent FeSi per net ton produced is used during this period.

The cupola metal as it is tapped from the cupola is at about 2750 F and is delivered to the open hearth furnaces at 2500 F. The metal leaves the cupola with the following approximate percentage analysis: 3.00 carbon, 0.35 manganese, 0.200 phosphorous, 0.130 sulphur and 0.60 silicon.

The metal is desulphurized by introducing sodium carbonate into the stream as the metal is being poured from the holding ladle to the transfer ladle. Fumes are carried off by an exhaust hood. To gain the maximum benefit from the sodium carbonate, the metal with the sodium carbonate added is reladled before the slag is raked off and the metal added to the open hearth furnaces. About 65 per cent of the sulphur is removed by the addition of 20 lb of sodium carbonate per ton of metal.

Numerous changes have been made on the cupolas to increase their production through the years. At the time of their construction and for some years after, they produced at a rate of 15 to 16 tons per hr. As mentioned earlier, they are now producing at about 23 tons per hr.

Some of the changes that have been made are worth mentioning here:

On the original stacks, the shells were all riveted. On later rebuilds, the plates were welded.

The original cupolas had a wind box 63¾ x 27-in. deep, set directly on top of the main tuyères and auxiliary tuyères were installed through the wind box.

The wind box was changed to 45-in. high and 22-in. deep and set five ft above the main tuyères so that external water cooling of the shell could be utilized and visual inspections could be made. The water cooling is accomplished by spraying water from three 2-in. pipes, with ⅛-in. spray holes, directed at the shell. This prevented cutouts as the linings became thin and allowed a longer run on each cupola. The auxiliary tuyères were discontinued.

The original slag trap box was 13-in. wide with a 4½-in. lining and had a 4-in. trough. With the change to longer runs on the cupola, it became necessary to change the slag trap. It is now 48-in. wide with an 11½-in. lining and has a 6-in. trough with air pockets on either side and a double slag strainer with an air pocket between strainers, cooled with compressed air. A water circulating breast cooler 18 x 20 x 2 in. was installed over the slag, metal taphole to protect the taphole of the cupola. The placing of the breast cooler is carefully done for leaking water in this area could be very dangerous. If the cooler is placed too low the metal will cut it, and if the cooler is placed too high it loses its effectiveness.

The cupolas were originally lined with cupola blocks and fireclay to 72 in. in the melt zone and boshed to 84 in. above the melt zone. The melt zone was patched with cupola blocks and fireclay after each heat. Iron brick were used below the charging sill for five ft. Later the iron brick were replaced with a steel casting and the cupolas lined to 72 in. throughout. The melt zone was patched with silica batts and high silica clay. Then the casting at the chill was eliminated and the cupolas were again boshed back to 84 in. above the melt zone. At the present time, the well and melt zone are being gunned.

Previously, a scrap charge of 5000 lb was loaded on one buggy, cast in the bottom and scrap on top. Coke and limestone were shoveled into another buggy. The coke weight was estimated. The metal and coke were dumped into the cupola separately. Due to uneven distribution of metal and coke, as much as one half of the coke charge had to be added at the sill by hand. The metal charge was cut to 3000 lb with coke and limestone in the center, cast in the bottom and steel on top on the first charge, and steel in the bottom, coke and limestone in the center and cast on top on the second charge. By alternating the cast and steel throughout the heat in the above manner, it was not necessary to add coke at the charge sill.

In 1946, a coke conveyor was installed with an automatic weighing hopper. This improved the accuracy of coke additions and speeded up operations.

Originally, charging buggies were pushed by hand to and from the transfer car. The tracks from the transfer car to the scales were inclined and electric pullers installed back of each scale to pull the buggies on to the scales. The inclined track permits loaded buggies to roll from the scales either to the transfer car or over the transfer car on to the skip hoist. A spare transfer car was installed to eliminate any downtime due to repairs on the transfer car.

The two cupolas originally had one 15,000-cfm blower. Time was lost in changing from one cupola to another. When blower trouble developed production could not be maintained, so a second blower was added.

The original cupolas had stoves fired with natural gas to preheat the air. Due to leaks, lack of proper temperature and high cost, the stoves were removed.

Originally, it was thought that the cupolas could be run with a metal to coke ratio of ten to one, but to produce satisfactory metal of proper temperature and analysis, it was necessary to use a metal to coke ratio of about 6½ to 1.

Surplus coke was unloaded and loaded with a clam shell. This method crushed considerable coke, so later conveyors and old hopper cars were used for storage. Sizing of the coke is very important and breakage in handling is to be avoided as much as possible.

Desulphurization was originally done by throwing

sacks of sodium carbonate in the bottom of the ladle. Due to heavy reactions and erratic results, a change was made. Sodium carbonate is now introduced into the stream pouring from the holding ladle into the transfer ladle and then the metal is transferred to another ladle for further mixing of the sodium carbonate slag and metal for more complete desulphurization.

Discussion

PRESENTED BY

S. TUNDER, Technical Director, Gesellschaft fur Huttenwerksanlagen, m.b.H., Dusseldorf, Germany (GHW)

E. S. HARMAN, President, E. S. Harman Corp., Chicago, Ill.

S. Tunder: The increase in open hearth tonnage from 11 to 16.5 tons per furnace hr by the addition of 42 per cent hot cupola metal is considerably higher than obtained in German practice.

The oxides in the slag consisting of 4 per cent FeO and 6 per cent MnO are considerably higher than obtained in a basic hot unit. With the high oxides in the slag, the scrap used for the charge would have to be restricted to good grades as rusty scrap would tend to further increase the oxides. With the basic hot blast cupola, rusty scrap can be used without restriction as the rust is converted to metallic by both the gas phase and the slag.

The author's description of filling the buckets with pig iron and scrap indicates Sheffield is using heavy scrap. In Germany heavy scrap cannot be used in the cupola because of high cost. Therefore the cupola shell in the basic hot blast design is larger in order to produce a good molten iron from light grades of scrap.

It is felt that if Sheffield would use water-cooled copper tuyères in its cold blast cupola, durability would improve and operations would be less expensive even when using an acid slag.

Desulphurizing by adding sodium carbonate between the mixer and the ladle is quite a complicated procedure, and it is felt that uniform results can not be obtained at all times.

At Sheffield the coke must be handled very carefully to avoid abrasion and breakage which would reduce coke size. Small size coke cannot be used in an acid operation whereas in the basic hot blast cupola, small size coke can be used.

In order to achieve flowability of the iron and prevent high oxidation in the cold blast acid cupola, cast scrap is used as at Sheffield because of its silicon content. But the cast scrap also contains phosphorous which is objectionable and must be removed in the open hearth. The metal produced in a basic hot blast cupola contains only 0.04 to 0.05 phosphorous and silicon is as low as 0.05, both because of the all scrap charge. The silicon, phosphorus and sulphur in the metal obtained from the cold blast cupola at Sheffield are all much higher than in metal produced in a basic hot blast cupola.

E. S. Harman: The author's comprehensive discussion of his cupola practice makes it possible to make a comparison between the acid cupolas installed in this country to increase open hearth production and the basic hot blast cupolas installed in Germany for the same purpose.

Germany obtains a 50 per cent increase in size of heats with a 50 per cent hot metal charge, but it is believed that the increase in tons per hr is not any higher than the 50 per cent obtained at Sheffield except in isolated cases. The problems in the U. S. have been with the acid cupola. In Germany they use the basic hot blast cupola and these problems do not exist. Hence it is felt that a comparison between the two types of cupolas will be of interest.

Briefly, the basic hot blast cupola has no lining above the tuyères. The hearth and bottom are lined with carbon brick which are never replaced. The bottom is a solid bottom and is never dropped. The shell and tuyères are water cooled. The cupola operates 24 hr a day with a 16 to 24-hr shutdown once every six to eight weeks for patching around the tuyères with carbon patch. About 0.8 lb of carbon patch, at about 5¢ per lb, is used per ton of hot metal produced for hearth patching and relining the slag separators. A one-hr shutdown twice a week is required to change the slag separator which is partially water cooled.

The blast is heated to 1100 F in a recuperator fired with cupola gas cleaned to 0.025 grains per cu ft. The cupola is smokeless, one third of the cupola gas being used for the recuperator, and two thirds of the gas amounting to about 1,250,000 Btu per ton of iron produced, is available for other uses such as boilers, or if mixed with natural gas, it can be used in soaking pits. The results obtained from the cupola described above are:

With the high blast temperature and properly designed tuyères which resemble blast furnace tuyères, the cupola operates on a 100 per cent steel scrap charge which can consist of one third turnings and borings, one third bundles and one third No. 2 heavy scrap. For a 3½ per cent carbon metal, the coke rate is 18 per cent. Foundry coke is not required. Either beehive or oven furnace coke can be used. Fluxes required are 6 per cent limestone and 2 per cent fluorspar. No ferrosilicon or soda ash is used.

With the above charge the analysis of slag and metal as compared with the acid cupola is approximately:

Slag

	CaO	MgO	SiO_2	Al_2O_3	FeO	MnO	Ratio CaO/SiO_2
Acid cupola, per cent	37	—	48	6	4	6	0.77
Basic cupola, per cent	50	7	27	8	—	—	1.82

Metal

	C	Mn	Phos	Si	Sul
Acid cupola, per cent	3.0	0.35	0.2	0.6	0.13

Basic cupola, per cent	3.5	0.40	0.06	0.1	0.02

Temperature of metal to mixer in a basic cupola = 2750 to 2850 F. By increasing the coke rate to 20 per cent, the carbon in the metal increases to 4.0 to 4.3 per cent.

Desulphurizing causes loss in metal temperature which probably accounts for a substantial portion of the 250 F drop in temperature between the cupola and open hearth cited by the author. With the basic slag, high blast temperature and a CO to CO_2 ratio of two to one obtained in the basic cupola, desulphurizing occurs in the cupola. This is not possible with the acid slag given for the acid cupola. It is important to mention that all carbon lined cupolas are not giving these results, partially because of design and partially because of operating technique. The cold blast acid cupola requires ferrosilicon to make up for lack of blast temperature. Fifty per cent of the ferrosilicon charged is burned in the cupola and lost. Silicon loss in the basic hot blast cupola when properly designed and operated amounts to about 10 per cent.

Pig iron, cast iron and foundry coke are other premium items which add to the cost of cupola metal produced in an acid cold blast cupola, and it was because of cost that many cupola installations of this type were abandoned. However, the need still exists for increased tons per furnace hr in cold charged furnaces, both open hearth and electric, in order to be competitive in the face of spiraling labor rates and the use of oxygen in hot metal shops. The answer lies not in the abandonment of cupolas but in the installation of a modern cupola which will give hot metal at a cost substantially the same as blast furnace metal.

As a brief example of what can be accomplished in the direction of cost reduction, if the practice outlined in the foregoing for the basic hot blast cupola could be applied to the practice for the acid cupola outlined by the author, the reduction would be approximately:

	Reduction per net ton of metal
1. Replacement of 25 per cent pig iron charge at $66 with 25 per cent No. 1 heavy scrap at $40 per gross ton.	$ 5.80
2. Replacement of 15 per cent cast iron scrap at $51 with 15 per cent No. 1 heavy scrap at $40 per gross ton.	$ 1.47
3. Replace 15.5 per cent foundry coke at $32 with 18 per cent furnace coke at $21 per net ton.	$ 1.18
4. Omission of 10 lb of 50 per cent FeSi at 14.6¢ per lb of contained silicon.	$ 0.73
5. Omission of 20 lb of sodium carbonate at 2½¢ per lb.	$ 0.50
Total reduction in cost of charge plus credit for 1,250,000 Btu of surplus cupola gas from basic cupola at 40¢ per million Btu.	$ 9.68
	$ 0.50
Total	$10.18
Less additional fluxes required for the basic cupola:	
Limestone 70 lb at $2.40 per net ton 08¢	
Fluorspar 40 lb at $30 per net ton 60¢	$ 0.68
Net reduction in cost	$ 9.50

If metal with 0.6 silicon is desired, FeSi would have to be added and the reduction in cost is reduced to about $8 per ton.

The unit prices used above are merely typical, but on the conservative side. If turnings and borings are available, they can be used to the extent of one third of the metallic charge, which would increase the cost differential as they are not commonly used in cold blast acid cupolas.

It may be of interest to mention that Laclede Steel Co. recently installed a steel conveyor belt to spread out No. 2 scrap for picking out nonferrous scrap. Two men, one on each side of a 30-ft long steel belt, sort 30 cars of scrap per 24 hr. By this process, residual copper is kept to within 0.18 per cent and the nonferrous scrap is salvaged. Such an installation permits the use of cheaper grades of scrap to a much greater extent and permits better control over residuals.

In addition to the savings listed in the foregoing, there is a net saving in operating expense, particularly in relining cost. The cost of hearth patching and relining the slag separators in the basic cupola amounts to less than 5¢ per ton of metal. In a modern cupola installation, automatic charging and weighing is accomplished by two men, a craneman and a weigher.

With the innovations outlined in the foregoing, conversion cost from scrap to cupola hot metal amounts to about $6.50 per net ton. With a scrap classifier belt as installed at Laclede and the use of one third each of No. 2 heavy scrap, No. 2 bundles and turnings, the average cost of the scrap charge will be in the neighborhood of $30 per gross ton, or $27 per net ton, giving a hot metal cost of $33.50 per net ton. If No. 2 bundles are replaced with No. 1 bundles, the cost of hot metal increases to about $37.50 per net ton.

At these costs the cold charged shop, after installing a basic hot blast cupola, is on better than equal footing with hot metal shops. Basic cupola metal has two advantages over blast furnace iron as a charge metal for open hearths and electric furnaces, i.e., it is 250 F higher in temperature than blast furnace metal, and it contains only 0.2 per cent silicon. Electric furnaces charged with 50 per cent basic cupola metal and 50 per cent scrap can reduce charging and melting time 50 per cent by melting with oxygen. Cold charged shops, both electric and open hearth, by installing basic hot blast cupolas and employing oxygen for melting, can successfully compete with oxygen converters charged with blast furnace metal. The basic hot blast cupola will produce hot metal of a quality suitable for blowing in an oxygen converter. The first such installation is at Witten, Germany. This plant has been in operation since early 1957 producing all grades of alloy and carbon steels. They can no longer afford to operate their electric furnaces or their open hearths on cold charge. ▲

Soaking Pit Expansion

KAISER Steel Corp.'s rolling facilities originally consisted of 12 bottom-fired soaking pits of 75-ton capacity each (Figure 1), which preheated ingots for direct rolling on a 110-in. plate mill. Presently, approximately 17 years later, there are 40 bottom-fired soaking pits of 120-ton capacity which preheat ingots for two primary mills, a modified 46-in. high-lift blooming mill, and a 46 x 90-in. universal slabbing mill. The history of the Fontana plant is readily discernible in the soaking pit records.

Prior to the $214,000,000 expansion of 1956, the original soaking pits had grown to 24 bottom-fired units, 22 pits of 75-ton capacity each and two pits of 120-ton capacity each. The soaking pit cranes had increased from one 10-ton unit to three 10-ton units, but the original building had not been altered except in length. Auxiliary facilities such as mold buggy tracks and ingot buggy tracks had grown in length with the building, but the original sand and coke bins were still utilized. Ingots were delivered to the 46-in. high-lift blooming mill by an 80-ton side-dump ingot buggy and a transfer car.

The original soaking pit building was constructed during 1942 and 1943. The length of the building was 475 ft and the width was 85 ft. This building housed the original six batteries of two pits each, which supplied the 110-in. plate mill with preheated ingots for rolling.

As production increased, additional pits were added in 1948, 1950 and 1952, see Figure 2. The building was extended westward from the original installation 475 ft, and the width of 85 ft was retained. In 1952 the total number of batteries was 11 of two pits each, each pit having a 75-ton capacity.

In 1953 the twelfth battery of two pits was added. This battery was the first of the 120-ton capacity pits and was to determine if the ingot product mix at Fontana could be heated efficiently in this type of soaking pit. This installation supplied in excess of 1,500,000 ingot tons annually for reduction to the primary product of slabs and blooms with comparatively few operating and maintenance problems. However, the rolling capacity of the modified 46-in. high-lift blooming mill was sorely taxed to convert this tonnage to slabs and blooms.

The 1956 expansion program was designed to double the ingot capacity of the Fontana plant so the need of an additional primary mill was apparent. After product forecasts had been evaluated and engineering studies were completed on several types of primary mills, the decision was made to construct a 46 x 90-in. universal slabbing mill as by far the greater percentage of future ingot tonnage would be required in slab form and the type product produced could be efficiently converted on this size mill.

In the preliminary engineering studies conducted on the layout of facilities for the 1956 expansion program, the slabbing mill was included as a separate unit supported by a block of soaking pits at a location that would allow the product a straight line flow to the contemplated new location of the 86-in. strip mill. After the entire expansion program was rounded out and the appropriation funds allotted, it was found this plan could not be consummated. The finances were not available to construct a separate pit building with

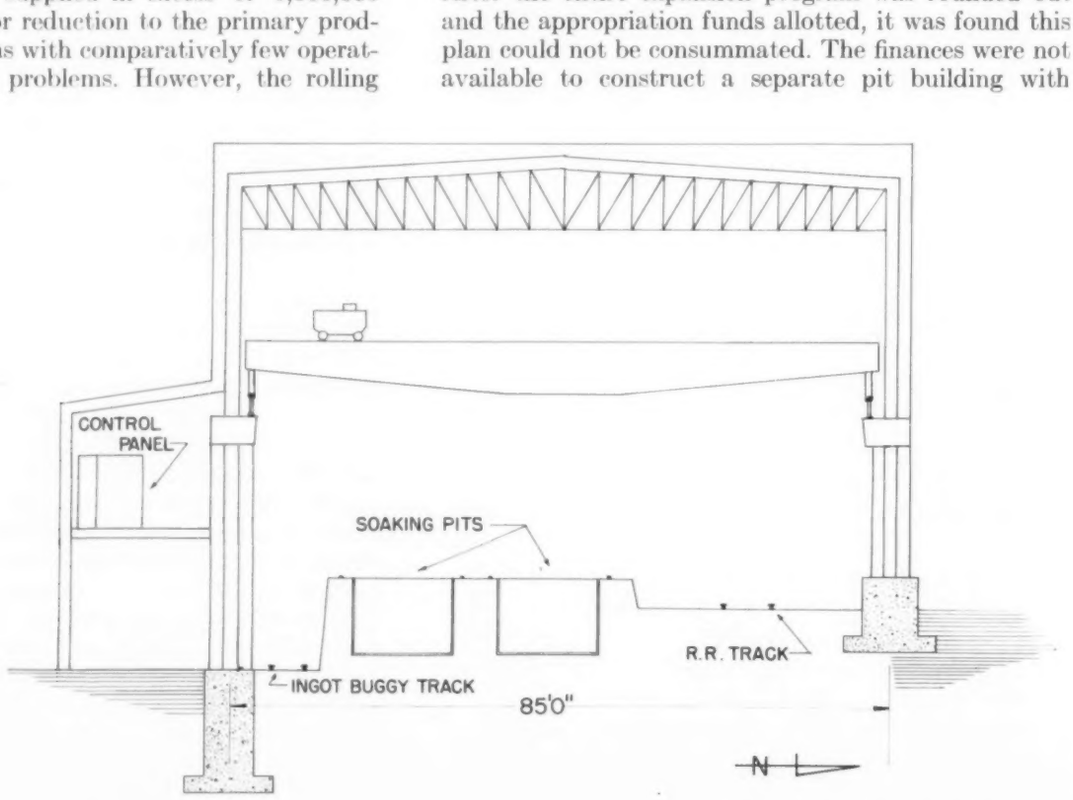


Figure 1 — The original soaking pit building contained six batteries of two pits each.

and Slabbing Mill Installation at Kaiser Steel's Fontana Plant

by MERLE L. GRUVER
Superintendent
Blooming, Slabbing and Structural Mills
Kaiser Steel Corp.
Fontana, Calif.

necessary utilities when evaluated with other units that were absolutely necessary in the scope of the program. The only alternative was to extend the present pit building and utilize the 24 soaking pits with their auxiliaries and serve both the proposed slabbing mill and the 46-in. blooming mill from the one installation.

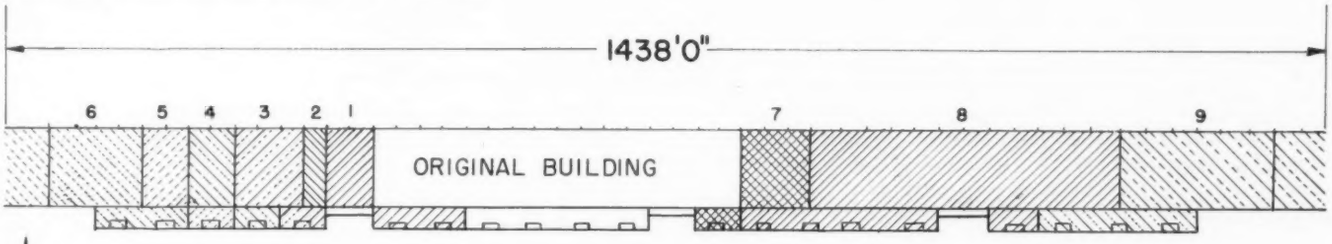
Numerous engineering and production problems are prevalent in installations of this type, but they must be solved to permit production of blooms and slabs at a competitive cost. As the engineering and construction problems preceded the production problems, a review of some of these items will be made at this time.

As shown in Figure 3, the soaking pit building runs east to west with the 46-in. blooming mill lying perpendicular to the soaking pits some 400 ft from the west end. The plate mill was also located perpendicular to the soaking pits 75 ft from the east end of the soaking pit building. At the west end of the soaking pits the topography of the ground slopes rapidly toward the west, and railroad tracks which service the pipe mills, merchant mill and west end branch warehouse cross the area. The slabbing mill could not be erected

. . . . mill expansion programs often involve unforeseen problems which must be solved to permit production to meet schedule demands . . . .

west of the blooming mill without spending a large sum of money for the renovation of the area. Also, the product flow would not be desirable for plate mill and strip mill consumption. East of the plate mill was the only location available where the present pits could be

Figure 2 — Many pit addition and building programs were completed since the original installation: addition 1, four pits; addition 2, no pits; addition 3, two pits; addition 4, two pits; addition 5, two pits; addition 6, four pits; addition 7, two pits; addition 8, ten pits; and addition 9, six pits.



1942	ORIGINAL BUILDING	PITS 1 THRU 8
1943	1ST. ADDITION	PITS 9 THRU 12
1943	2ND. ADDITION	NO PITS ADDED
1948	3RD. ADDITION	PITS 13 & 14
1950	4TH. ADDITION	PITS 15 & 16
1950	5TH. ADDITION	PITS 17 & 18
1952	6TH. ADDITION	PITS 19 THRU 22
1953	7TH. ADDITION	PITS 23 & 24
1956	8TH. ADDITION	PITS 25 THRU 34
1959	9TH. ADDITION	PITS 35 THRU 40

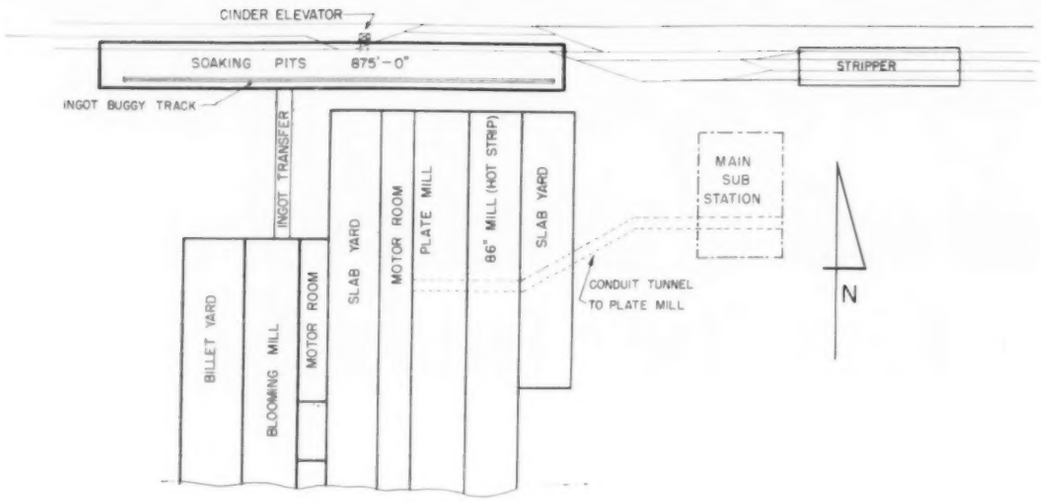
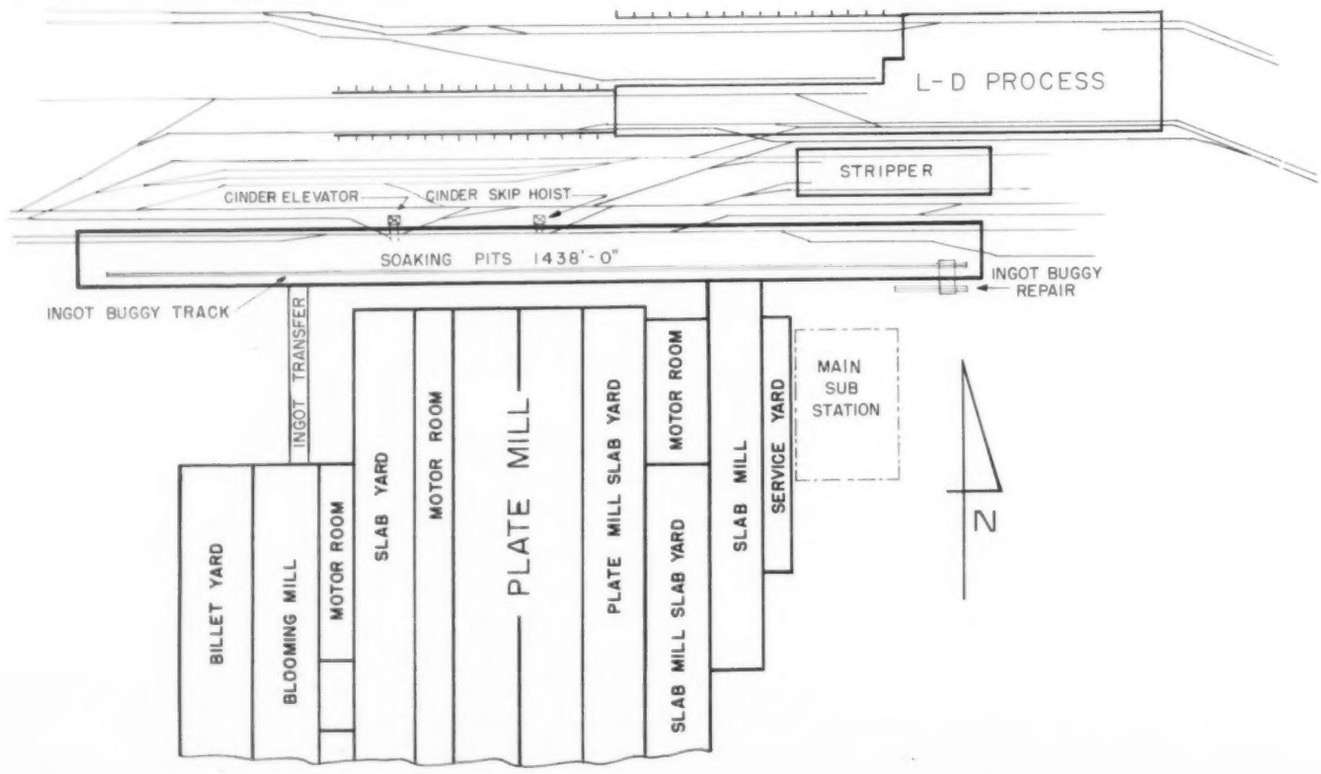


Figure 3 — The topography and the location of existing equipment did not permit use of the most desirable product flow arrangement. Layout shown is that in 1953.

utilized and the product flow would be in the correct direction.

When preliminary layouts were made of the slabbing mill at this location, it was found that the main substation located on the east would not limit the width of the main mill building and motor room but that the crop and scale service yard width would be confined to a space of 32 ft, see Figure 4. The limitations in the service yard were overcome by designing a long narrow scale pit which can hold approximately four turns of scale produced at the mill. The scale was to be loaded by an overhead crane into either railroad scale cars or trucks. A crop conveyor was installed from the mill shear to a crop pit located in the service yard. Due to lack of sufficient space, the size of the crop pit is limited to approximately four-hr mill crop production. The same overhead crane which services the scale pit removes crops from the crop pit. A method had to be derived to remove crops at a faster rate than they could be produced to allow scale removal at certain intervals. This was done by designing a special double hook crane and equipping it with power for two magnets. Both the scale buckets and magnets are equipped with spreaders that allow a quick change on an as-needed basis. The water-proof magnets are 65 in. in diameter and are protected so that they can work in the crop pit when the mill is operating. A railroad track running the length of the yard on the east side allows two railroad scale cars and six 70-ton railroad crop cars to be serviced by this crane. A railroad shift is required approximately every 8-hr operating turn to remove the crop cars and approximately every three

Figure 4 — It was necessary to design special equipment and make engineering changes in order to fit the equipment in the space available. Layout shown is that in 1960.



turns to remove the scale cars.

Traversing the area of the new slab mill location from a line lying roughly from the northeast to the southwest were the main cable lines from the main substation to the plate mill motor room. Lack of funds did not allow a major expenditure for the relocation of these lines; therefore, a major engineering change was required in the slabbing mill construction. The flume system for the removal of scale from the main mill and the mill tables was a water flume removal type common to many mills of similar design. The interference of the main power lines to the plate mill was circumvented by placing the cable lines in a heavy concrete encasement and dividing the flume into two segments: one to service the area north of the cable crossing with an outlet to the scale pit, and one to service the area south of the cable crossing with a separate outlet to the main mill flume. This method required major changes to the piping for the flume and a tunnel from the south flume to the scale pit. To maintain the correct elevations the south flume was sloped in two directions: from the crop shear north and from the cable crossing south. At the point of intersection a tunnel was constructed to the main mill flume outlet at the scale pit.

On the south end of the mill location, space limitation required the product to be transferred to the west via a chain transfer and drop out with the pilers being located just outside the main mill building in the slab yard running south from the main mill motor room. This area had a width limitation of 100 ft because of the adjacent plate mill slab yard to the west. The slab yard was extended south to the practical crane-travel-time limitation in removing slabs from the pilers. As this did not allow enough slab storage space, two 50-ton transfer cars were installed in order that slabs may be transferred direct to the plate mill slab yard and to provide an additional storage and processing area for slab product going to the plate mill.

Other features that were designed for the mill to facilitate production and that deserve consideration are: a turnaround in front of the mill which automatically weighs the ingot and transmits the weight to the recorder located 400 ft away, water-cooled sideguards on the front and back manipulators, a direct drive shear and a slab scale that weighs the slab and transmits the weight to the recorders' pulpit. A recording system identifies ingot number, heat number, ingot weight, the time it was rolled and what the product was from each ingot. An automatic slab stamper is used to place the ingot number, cut number, heat number and crew number on each slab. A complete communication system is located in each operating pulpit and is also connected to the soaking pit operating floor.

The electrical drive arrangement for the 46 x 90-in. universal slabbing mill consists of two 5000-hp motors making up the 10,000-hp twin-motor main drive and a 4000-hp edger motor. The power is supplied from four 2500-kw and two 1750-kw generators making up the 13,500-kw flywheel motor-generator set.

When the modified 46-in. blooming mill was installed in 1954, a new higher torque, lower speed, 5000-hp motor was purchased for this mill in anticipation that the motor would be used in a future installation of a larger primary mill to supply slab product to the finishing mills when product tonnage of the modified 46-in. blooming mill would be exceeded. The construction of the 46 x 90-in. slabbing mill created the situation where this motor could be utilized. A new 5000-hp motor was purchased to match the existing 46-in. modified blooming mill 5000-hp motor to make up the 10,000-hp twin-motor main drive. When the new slabbing mill reached a point in construction where everything was completed to receive this motor, a planned shutdown of the blooming mill was made and the 5000-hp motor was disconnected and moved to the slabbing mill. The original 5000-hp motor of lower torque and higher speeds was reinstalled at the blooming mill. This job was completed in a minimum of time and both mills were operating within hr of each other. The preplanned usage of the higher torque blooming mill motor saved a considerable amount of funds in the purchase of the electric motors for the slabbing mill and also served the blooming mill in the meantime so that slab product size could be increased, which helped the finishing mill production rate.

In the electrical drive arrangement of the new slabbing mill each of the two 5000-hp single armature main motors are supplied by two 2500-kw generators. This setup is designed so that the mill can run with any three of the four generator sets in operation. The 4000-hp double-armature edger motor is supplied by two 1750-kw generators. The use of the separate generator supply for the edger motor permits usage of voltage control for draft compensation and also allows independent jogging operation of the edgers and each main motor.

The design of the main motors, edger motor, supply generators, etc., is co-ordinated to enable the reversal of the main mill drive, without steel in the mill, from full field base speed forward to full field base speed reverse in a minimum time of 1.5 sec, and reversal from 200 per cent of base speed forward to 200 per cent of base speed reverse in a minimum time of 3.75 sec.

The 13,500-kw, 8-unit flywheel motor-generator set consists of four 2500-kw current generators, two 1750-kw current generators, one 9000-hp type CW wound-rotor motor and a 100,000-lb, 168-in. diameter laminated steel plate flywheel which has 215,000-hp stored energy when running at 514 rpm. The total net weight of this set is about 300 tons.

A pressure circulating oil lubrication system supplies lubricating oil to the main motor-generator set, main mill motors and edger motors. A cooling and recirculating downdraft ventilation system provides the cooling air for the motor room.

The balance of the electrical equipment on the mill is supplied by three auxiliary, variable-voltage, motor-generator sets driven by 1100-hp induction motors. Each of these sets has seven generators. One generator on one set is a standby generator for any one of the 16, 150-kw regular generators. In addition to the seventeen 150-kw generators there are three 350 and one 125-kw generators. One set has an exciter for the three 1100-hp motors and associated control equipment. There are four regulating sets which excite and control the 20 variable-voltage, auxiliary power supply generators. These sets are so arranged that operations can be maintained with any one of the three sets out of service.

The ingot heating capacity necessary for the 46-in. blooming mill and the new 46 x 90-in. slabbing mill far exceeded the 24-pit capacity available. The first step in increasing pit capacity was to rebuild the 22 pits of 75-ton capacity. The pits were the bottom-fired double-recuperative type and were built with two pits to a battery. The recuperators were located two on each side of each pit. The flues from the recuperators ran south under the ingot buggy tracks to the stacks which were located outside of the building. On the north side of the pits the distance from the pits to the north building column was approximately 14 ft. This space was utilized by a broad gage railroad track for incoming heats and a bank for stripping hot top ingots or storing cold steel. The ingot delivery buggy clearance on the south side of the soaking pits was but two in. These clearances made enlargement of the pits, with their respective recuperators, to the north and south impractical. The dimensions of the pits were 13 ft-6 in. long by 14 ft-3 in. wide and 99-in. deep. The most desirable capacity the pits could be enlarged to was 120 tons as this would accommodate one half of an open hearth heat or one oxygen furnace heat. After engineering studies were made, soaking pits No. 1 through 22 were enlarged to 13 ft-6 in. by 18 ft by making 22½ in. available on the east and west sides of the soaking pits. This was accomplished by removing insulating brick, narrowing the preheated air chamber and wall between chamber and recuperator tubes and by redesigning the recuperator chamber to allow a different layout of tubes. Two rows of tubes were removed next to the pit proper and added on the north and south sides of each recuperator chamber. This increase in size provided an additional pit capacity of 1000 tons of the needed expansion tonnage. This work was accomplished from June, 1956 through September, 1957, while operations were in progress.

In the expansion program there were funds available for ten additional soaking pits. Because of the building limitations and limited engineering time available to redesign another type pit to fit in the extended building, it was decided to construct the same type bottom-fired pit with a capacity of 120 tons. From an engineering aspect this was not the best solution but circumstances required that this procedure be followed.

After locating the mill and increasing pit capacity, the problem of delivering ingots to the new slabbing mill had to be engineered. Product forecast dictated new ingot sizes. New molds were designed to increase ingot weight to a maximum of 40,000 lb from 34,000 lb. The number of ingots to be processed would eventually double in number so the operating pit cranes were studied to determine if they could handle the increased ingot weight and number of ingots plus the auxiliary workload. There were three 10-ton cranes available of which two were used simultaneously to operate the 24 pits and the 46-in. blooming mill. It was determined that the existing three cranes required new worm drives and larger motors on the hoist to increase their capacity to handle ingots of 20 tons. These units were purchased from the crane manufacturer and installed during operating periods prior to the operation of the new slabbing mill. It was found that three cranes were insufficient to handle the proposed tonnage increase, and a new 20-ton crane was purchased to handle the increased workload. The increase in ingot size and required number of ingots to be delivered to the new slabbing mill rendered the 46-in. blooming mill ingot buggy obsolete. It was too small to perform the required work. A study was made to determine the most efficient method to deliver the necessary number of ingots to the new mill. The new slabbing mill lay-down table was in excess of 1100 ft from the most western pits and only one battery of two pits in the new expansion were located east of the slabbing mill lay-down table. The westernmost pits had to be utilized to provide a sufficient supply of ingots to the new slabbing mill, and the distance required a method that would provide fast delivery while hauling at least two 34,000-lb ingots. The majority of these ingots are rolled double and mill rolling capacity demanded that this type of service be available for efficient operation.

The side dump characteristic was hard to cope with and the location of the lay-down table with respect to the pits did not tend to encourage a cable-driven buggy. After much research and exhaustive studies, two 120-ton remotely controlled electric driven buggies were provided. Because of their size, there were operating and maintenance limitations that had to be engineered before the mill started up. The new ingot buggies could not pass west of the 46-in. blooming mill lay-down table. As funds were not available to alter this table, it was decided to utilize the pits west of the lay-down table, of which there are ten in number, for blooming mill product. Due to the increase in weight of the buggies, the ingot buggy track had to be reinforced and the track section made heavier to support the increased load. This was done by prefabricating steel panel sections that would fit the present supporting piers. A total of 350 ft of old track was replaced in this manner while operating the 46-in. blooming mill. As these buggies operate inside the soaking pit building, the problem of changing trucks and drive motors had to be solved. The soaking pit cranes auxiliary hoists are only 15 tons and could not be used for maintenance of these buggies. A transfer pit was built east of the soaking pit main building. It was arranged with a repair pit located south of the building equipped with permanent jacks of ample capacity in order that either buggy can be moved over this pit and repaired with a minimum of lost time.

The remote control electrical system on these buggies was designed to operate both buggies simultaneously, in order that ingots could be transported to the mill two at a time from the most western pits, to maintain production.

Figure A shows the geographical location of some of these new units. Some operating problems which have been encountered since these new units were placed in operation October 8, 1958, will be explained:

The ingots for the soaking pits and primary mills are received from two sources: the open hearth shop located east of the soaking pits and the oxygen furnace shop located north of the pit building. The oxygen steel shop has a stripper crane located within the building while the open hearth has two stripper cranes that are located in a separate building which is between the soaking pit building and the oxygen shop.

One of the first production problems encountered was the delivery of ingots to the soaking pits from both sources simultaneously through a common

opening on the north side of the soaking pit building. The soaking pit building had three openings on the north side with spur tracks running west to south in the soaking pit building to correspond with the flow of ingots from the open hearth. The delivery of ingots from the oxygen furnaces was the exact opposite as they are delivered to the soaking pits from a west to south direction. This caused interference on the delivery of heats, and as tonnage increased the situation became intolerable. Other items that greatly aggravated this situation were that but one delivery track was available in the soaking pit building and that all switching of drags in the pit building is done by the pit cranes, for soaking pit crane cab clearances do not allow locomotives to enter the building.

Operating practice of banking cold steel and stripping all hot top ingots in the soaking pit building prohibited the construction of a second track. However, the delivery problem increased as ingot tonnage increased and heats were being held up unnecessarily outside the pits and open hearth drags and oxygen drags were being mixed up. The extra switching required to separate empty drags added up to more delay time. A study was made by the operating and engineering departments and the problem was solved by adding a double track on the west end of the soaking pits for a distance of approximately 275 ft into the building. An additional door was added with a connecting spur running from west to south whereby oxygen steel ingots can be delivered to the pits and empties returned without the previous interference. This has also reduced track time on oxygen steel by five min per heat, which is helpful, but the big advantage has been the elimination of oxygen delivery delays caused by open hearth heat interference. The soaking pits had to lose approximately 200 ft of the space formerly used for banking cold steel and stripping hot top ingots. If it is necessary to charge hot tops in this area, an empty drag can be utilized. The crane operator strips the ingot from the mold on the outside track and lays it on the empty drag and then picks it up by the butt and charges it in the pit upside down. Cold steel is banked east of the double track and carried by the crane to any pit in this area that is to receive cold steel; or, if conditions prevail, cold steel is left on the cars and charged direct to pits in this area.

The forecast of ingot tonnages to be handled and product mix planned for the expansion did not materialize. Scheduling of ingots from the two steel producing units for the two primary mills through a single soaking pit operation became a major problem. The steel available in the pits at any given time could not support the 2-mill operation over an 8-hr period. The original schedules were found to be inadequate; steel would be ready to roll and the wrong mill would be rolling or vice versa. This required the scheduling of an excessive number of rolling turns and overtime, which at times caused an extremely high rate of cold steel delays. The fact that the anticipated expansion product mix did not predict the ingot sizes actually required threw a production load on molds of minimum inventories. The impact of this situation caused many production problems in soaking pit operation. Bloom ingots had to be held in the pits excessive lengths of time and slab ingots were subject to the same condition. Pit utilization was reduced and a charging pattern could not be maintained whereby bloom ingots could be charged in the westernmost pits near the blooming mill lay-down table and slab ingots in the east pits near the slabbing mill lay-down table. This caused delay in delivering ingots from the pits to the mills during 2-mill operation as the ingot delivery buggies run on a common track and one of the mills would have to be shutdown until pits were emptied. The situation has been alleviated by staggering the schedules of the primary mills whereby the 2-mill operation only has to be sustained over a 4-hr period. Also, a program has been followed to make adjustments in mold inventories whereby a sufficient number of mold sizes are available to meet the present product variation demands.

The new slab mill ingot buggies were a constant source of operating trouble. Due to the weight involved and the long distances of travel, the electrical components of the drive that governs the acceleration and travel speed required a complete revamping to obtain maximum efficiency. This consumed valuable production time in tryouts and testing. The remote control system that is used to control the buggies had to be duplicated at the control station so that if trouble is encountered in the control panel a duplicate control set can be used while the first panel is repaired, thereby decreasing production interruption time. Present operation of these buggies is acceptable.

The auxiliary work done by the soaking pit cranes in the pit building in conjunction with the heating of ingots such as coking of pits, stripping of hot top ingots, servicing masonry people repairing pits, sanding pit curbs and removing scale and debris from the pit areas is time consuming and presented a problem as to workload on the cranes. Formerly on the 46-in. mill operation with an average of 4851 tons of ingots processing through the pits daily, two of the three existing cranes were manned constantly. When 2-mill operation came into existence, 22 pits were expanded and ten additional pits were added to the original 24 pits. As previously stated, another overhead crane was erected in the soaking pits. Operation of two mills started with three of the four cranes being utilized. When tonnage began to climb between the 6500 and 7200-ton range, the auxiliary moves required to support 2-mill operation required the fourth crane to be operated. This posed a question of what had to be done when the capacity rate of 3,000,000 tons per year had to be met with a daily output of between 8000 and 9000 ingot tons. Studies were made to determine how many auxiliary operations could be removed from the soaking pit crane workload. One of the most time consuming jobs was coking the pits and making bottoms. The coking operation is done twice per week and bottoms are made once per week. Thoughts were given to establishing a method of coking pits without utilizing a pit crane, but studies made of different types of equipment available to perform the job found that accessibility to the pit area was practically nil at the maximum rate of production. The alternative method was to try dry bottom pits and eliminate coking and bottom making entirely. A program was immediately installed and dry bottoms were studied to see if metallurgical and heating practices were comparable to coked bottoms. Presently, the pits are operating on dry bottoms. Other studies

are being conducted on sand handling and removal of pit debris to further reduce pit crane workload in order that pit cranes can be utilized to a greater extent in handling ingots in and out of the pits.

A common problem that coincides with increased production is the training of personnel to operate new facilities properly and become efficient in the shortest period of time possible. When the new facilities were placed in operation at the soaking pits and the new slabbing mill began to roll product, this problem existed and had to be solved. Supervisory and operating personnel were instructed by the builders of the new equipment and the engineering staff people involved in the design and installation. This was accomplished by using the "dry run method." When actual production began, the various operating techniques were immediately finalized and incorporated by the operating and staff people into written job instruction sheets which were issued to all personnel concerned. This written job instruction performed an excellent job of communication and permitted standardization of the new operations.

Production in the first six months of 1959 increased from approximately 210 tons per operating hr to about 275 tons per operating hr. When ingot tonnage increases and further improvements are installed, the operating rates should level out at approximately 350 to 400 tons per operating hr, depending on availability of hot steel.

The slabbing mill has not experienced any major breakdowns that have required large scale engineering design changes. However, there were several changes made in the equipment after the mill began rolling.

The mill lay-down table is constructed with 18-in. diameter solid steel rolls having brass bushings on the first 14 rolls. The table is powered by a 50-hp motor. Unfortunately, this table cannot be serviced by the slabbing mill building proper. A 10-ton maintenance crane was erected over the lay-down table to change rolls, lineshafts, etc. The trouble that arose in this took place when an ingot placed on the lay-down table had a heavy fin, or fell down and became wedged between sideguards, there was insufficient power to move the ingot and numerous delays were encountered. A study of the table design was made, and it was found that a heavier motor could be installed to allow more power on the table rolls. The installation of the larger motor has reduced delays of this type.

The operating pulpit of the main mill is located on the south side, for the vertical rolls are on the delivery side of the mill. All ingots are delivered on the north side of the mill from the soaking pits. The vision of the mill roller and of the manipulator operator was obscured by the vertical rolls. If an ingot fell down, or if two ingots were being rolled simultaneously and were not separated properly before entering the mill, the operators could not see the trouble. This was a severe condition and several times ingots entered the mill crosswise. A television camera was installed on the north side of the mill with a receiver in the pulpit between the roller and the manipulator operator to give them the vision required to do their job.

When production increased, it was found that the original cast sectional skids on the elevator pilers and the piler skids were much too light for the hot slabs. They were continually warping and being torn off when slabs were pushed over them. Billets of 4-in.-sq 1040 steel running the length of elevators and pilers were substituted.

The chains on the transfer bed from the mill to piler bed did not function properly after being exposed to heat. The chains were reworked allowing more clearance and water cooling was added.

The electronic ingot and slab scales have not operated too well. They seem to be too fragile for this type of operation. However, continued experience on maintenance and operation of these scales is being carried out and it is hoped that solution will be found to assure their dependability, as their value to control yield and record statistical information is a needed production tool.

Discussion

PRESENTED BY

W. E. DITTRICH, Superintendent, No. 2 Mills Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

MERLE L. GRUVER, Superintendent, Blooming, Slabbing and Structural Mills, Kaiser Steel Corp., Fontana, Calif.

EMIL McGAUGHEY, Superintendent, No. 3 Blooming Mill and No. 4 Slabbing Mill, Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

W. E. Dittrich: How often are the dry bottoms made, and how long are the pits out while the bottoms are being prepared?

Merle L. Gruver: Dry bottoms have been very successful. This procedure was started June 15, 1959, and one pit has only recently been taken out of service (April, 1960). Approximately a foot of soup accumulates in the bottom, then the pit is taken down and cooled. It takes about 16 hr to remove the steel from the bottom of the pit. About 2 in. of periclase is used to dress a new bottom and is very successful in keeping the steel out of the bottom of the pit during the time the pit is operating.

The crane utilization load has been reduced approximately 54 per cent. The use of dry bottoms eliminates the removal of the cinder from the pit basement, allowing a reduction of the working force. Also the masonry cost was reduced by about 20 per cent per month.

Emil McGaughey: The author has had considerable difficulties with his recording instruments. Inland Steel Co. has had similar experiences. Would the instrument builders take note: there is nothing on the market today, that we have been able to find, which gives adequate recording on slab and ingot scales.

As the author has pointed out, these instruments are so sensitive that vibration set up from heavy equipment makes them inadequate. The inadequacy of these instruments is such that not only is yield lost but confidence in the instruments themselves has declined.

Merle L. Gruver: Certainly the manufacturers of this type of equipment should design better instruments for application in steel mill work. Instrumentation that fails because of the temperature variation or vibration cannot be used. ▲

The Automated Blast Furnace—Fact or Fiction?

by J. E. ORAM, Industrial Engineering Operation,
Mining and Materials Handling Engineering, General Electric Co., Schenectady, N. Y.

....computer controls applied to the blast furnace may permit substantial coke savings and increase production....economic justification is an individual problem to be solved for each furnace....

IT has been said that one of the most effective ways of avoiding a question is to ask the question. Accordingly, it will be noted that the title of this article is a question, not a statement. It is not proposed to answer this question but rather it is hoped to provide some thoughts which may enable one to draw his own conclusions.

Part of the difficulty in arriving at an answer to this question, an answer to which all could subscribe, stems from the difference in mental image which the term automation takes for each of us. To some the automated blast furnace denotes a furnace with the latest in recording instruments and a programmed automatic charging control system. To others, the term automated blast furnace might denote a blast furnace completely controlled and monitored by means of a digital computer. For purposes of this discussion the latter definition will be used.

In the course of the past few years, a considerable amount of time and money has been spent studying the blast furnace process, and discussing with the operators some of the problems associated with control of the blast furnace process. It was not the intention to become process experts. Rather it was hoped that sufficient knowledge about the process would permit utilization of the available knowledge of electric drive and control systems in developing a flexible blast furnace system which would fill needs in operating the blast furnace. Therefore, the thoughts and ideas presented in this article are to a large degree a reflection of your operator's thoughts on the subject in combination with a knowledge of control systems. The point to be made is that the development of these automation systems must of necessity be a joint endeavor with the full cooperation of both the control systems expert and the process expert. As pointed out earlier, this approach has stemmed largely from a cooperative exchange of information between respective companies, and continued expansion of these ideas will require continued joint efforts, perhaps even more intensive than heretofore undertaken.

An important influence on the decision, to devote a considerable amount of time and money to the development of the automated blast furnace concept was, of course, the increasing interest which the steel industry has shown in this area of operation. An indication of this increasing interest is the large number of technical papers and treatises which have appeared in the technical literature within the last three or four years. It is virtually impossible to pick up a steel industry trade journal without finding at least one or more papers on the subjects of automatic tuyère proportioning control, better distribution of burden, gas enrichment of blast, oxygen and moisture control of hot blast, control of blast conditions in response to the differential pressure drop configuration up the stack, or any one of dozens of other subjects.

It is also interesting to note that the rather meager information which is available concerning the programs being conducted by the Russian steel industry indicates that they are doing some of the things which we have been proposing for the past two or three years. This apparently is particularly true in the area of application of the digital computer to the "direction" of the blast furnace. For example, in the May, 1959, issue of *Control Engineering* magazine extracts were presented from a report prepared by the Soviet Central Automation Laboratory which made the following statement:

"The Russians have, according to the report, both a short-range and a long-range approach to the problem of blast furnace control. For the short range, the Soviets are applying elaborate automatic data-logging systems, known throughout Russia as foremen's friends. Computer-type logic circuits, using solid state devices and transistors, analyze incoming furnace performance data against preset instructions.

"In the long run, the Soviets are striving for full automatic control. The diagram (shown in the report) indicates how, by full control, the Soviets mean to direct four main functions: (1) furnace heating, determined from continuous analysis of combustion products: (2) input blast to the furnace, controlled from differential pressure measurements between top and bottom of the furnace and the dust collectors; (3) order variation of loading coke and ore charges to

the furnace, dependent on the temperature profile across the furnace; and (4) quantity or variation of charge loaded, to maintain even circumferential temperature distribution."

Quoting from the same article:

"At the Donetz Industrial Institute, engineers are working on a different approach. They are trying to maintain a continuous mass balance between the materials fed in and emerging from the furnace. Mathematical representations are being studied to obtain the operational equation that can be programmed into a computer. The computer would then adjust controller set points and provide data on the rate of charging required."

Quoting from the February, 1959, issue of *Computers and Automation* magazine:

"A new universal computer, called the Kiev, is now being assembled at the Ukranian Academy of Sciences. This machine, the work of Ukranian scientists Academician Boris Gnedenko and Professor Victor Glushkov, can be used for solving a wide variety of mathematical problems, for controlling production processes at metallurgical works, chemical, oil, and other industrial plants. It is reported to be capable of establishing in a matter of a few minutes the optimal method of operation of a blast furnace depending on the quality of ore, coke and sinter cake of the charge. By means of automatic devices, the machine maintains the mode of operation it had set, and signals when the pig iron is ready for tapping."

It is rather difficult to draw a specific conclusion as to the real progress which the Russians are making in the area of process direction of the blast furnace, but these reports are certainly indicative that the Soviet Union is showing an active and aggressive interest in these techniques. These reports in themselves should be no cause for undue alarm, but should signify that every possible new technique and practice must be used to improve our operations.

From this it can be seen that it was not a single factor alone which led to the conclusion that the iron and steelmaking area of the steel plant, and more specifically the blast furnace process, was an attractive area for application of some of these new automation techniques. Rather, it was a combination of many factors which influenced this decision to take an aggressive role in the development of blast furnace automation systems.

With this introduction, an examination of the present status of blast furnace automation systems and the attempt to develop an approach which will allow the evolutionary development of the ultimate blast furnace process director is certainly in order.

PROPOSED APPROACH TO THE AUTOMATION OF THE BLAST FURNACE

Some of the general characteristics of the blast furnace process and some of the available means of control should be considered. Although not a complete list, a few of the more important characteristics of the process are:

1. The process is a continuous process, but utilizes a batch charging system and a batch output system.

2. The process is a smelting process, and is not a refining process in the same sense that the open hearth or oxygen converter processes are refining processes. In other words, there is essentially only one basic product, with relatively broad limits allowed in metallurgical characteristics. Furthermore, the fact that these limits are exceeded, does not constitute a complete loss of the product.

3. Long time constants or transport times characterize the process.

4. The process is a high volume process, and accordingly has high economic value. Therefore, small improvements in process efficiency or productivity can justify rather sizable capital expenditures.

5. Primary control of the characteristics of the final product is through raw materials control or charge control. The primary or major control of the end product is achieved through the correct proportioning of the available raw materials (iron ore, sinter, stone, dolomite, mill scale, coke, etc.). One might define the correct charge as being one which will result in smooth, even operation of the furnace, minimum fuel and flux consumption, maximum efficiency in terms of tons per hr of production and the desired metallurgical characteristics in the final product. It is entirely possible that the industry would be unable to define the perfect charge necessary to accomplish all of these aims, at this time, but this of course is the objective for which all furnace operators strive.

6. There are a number of secondary controls which provide a vernier control means during the time that the raw materials are being transported through the furnace, such as:

a. Wind rate.
b. Wind pressure.
c. Wind volume.
d. Moisture content of blast air.
e. Oxygen and/or natural gas enrichment of the blast.
f. Distribution of blast air by tuyère proportioning control.
g. Top pressure control.
h. Distribution of raw materials as they are charged into the furnace.
i. Control of stock level.
j. Blast temperature control.
k. Others which have not yet been fully demonstrated, such as injection of fuel oil, powdered coal, powdered flux material, etc., into the blast.

Recognizing that the primary means of control is through charge control, it would appear desirable to design the systems to provide the furnace with the most refined and correct charge possible, in light of our present knowledge of charge calculations. Furthermore, the system should provide for expansion of this concept of charge control as we become more knowledgeable and are better able to define the correct charge for the furnace.

An important element in an effective charge control system, of course, is a flexible charging system which can effectively and automatically charge the various raw materials in response to the furnace operator's instructions. The blast furnace charging system has been the subject of considerable attention in recent years, and as a result, programmed automatic charging

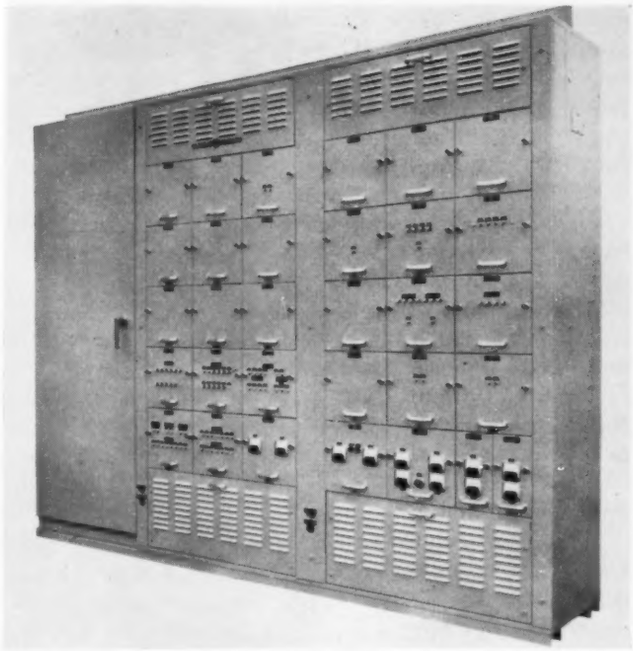


Figure 1 — Programmed automatic systems for burden control have been developed.

systems have been developed and are available today.

Figures 1 and 2 show a blast furnace programming and automatic charging control panel which will soon be installed in a steel plant in the Pittsburgh area. Push keys and selector switches have been utilized to simplify the program selection, thereby allowing the operator to change his charging program easily and quickly. The equipment is transistorized and of modular plug-in design to assure maximum reliability and ease of maintenance. Figure 3 shows one of the drawers of logic circuitry, showing the various plug-in logic units mounted vertically in the drawer. Figure 4 shows the manual operator's console for this particular installation, which was designed to provide the stockhouse operator with a visual display of the operational status of the various elements of the furnace system. Note that a considerable amount of graphic indication is provided in order to give the operator the furnace situation in a glance.

Figure 5 is a simplified block diagram of the blast furnace control system as known today. It will be noted that the main elements of the control system are comprised of a programming and automatic charging control plus a number of local analog controllers such as the hot blast temperature controller, wind rate controller, moisture addition controller, etc. The program selection of the automatic charging system and reference or set-point selection for the various local controllers are established by the operator and periodically adjusted in accordance with his observations of key furnace operational conditions.

As indicated earlier, programming and automatic charging systems are available today, and local controllers are available for most of the secondary control functions known today. However, in such a system there are several potential sources of error or difficulty. The programming and automatic charging systems are designed to charge the selected raw materials in a given sequence and to supply them in the prescribed quantities by weight. If it was assumed that the raw ma-

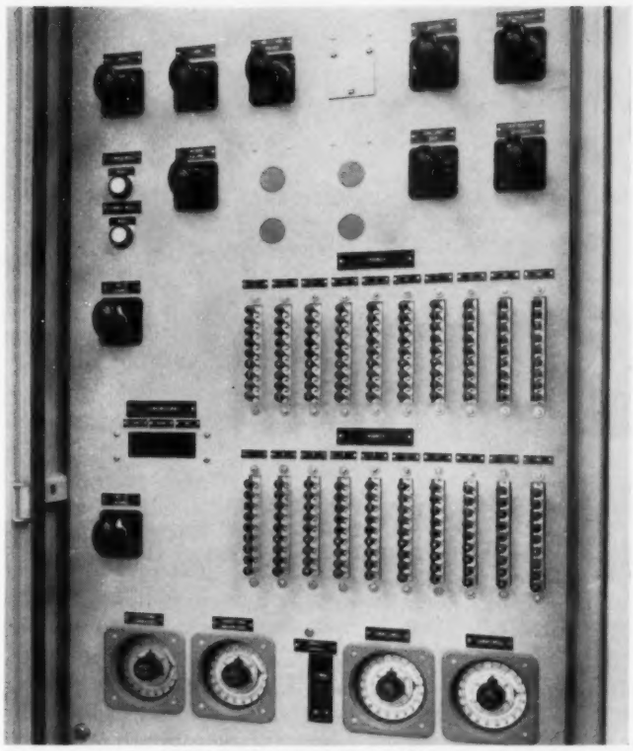


Figure 2 — Simplicity of control permits a quick change in the charging program by the operator.

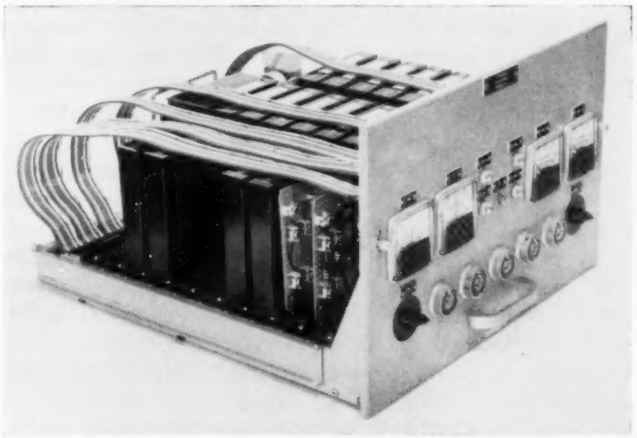
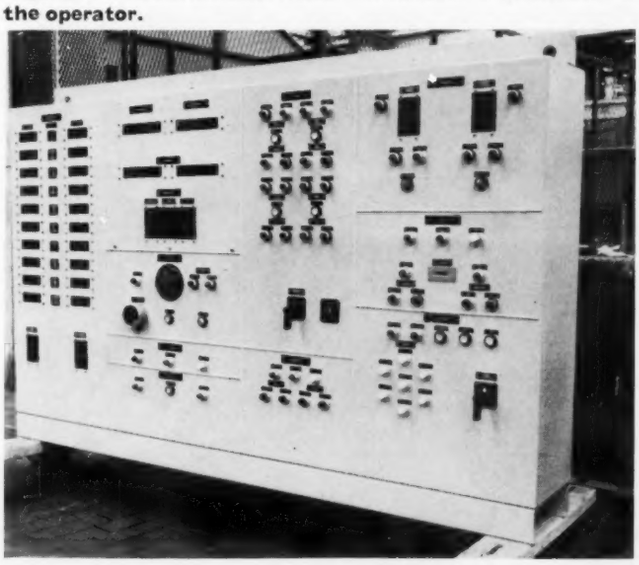


Figure 3 — Plug-in units allow quick replacement and reduce out-of-service time.

Figure 4 — Considerable visual indication is provided to the operator.



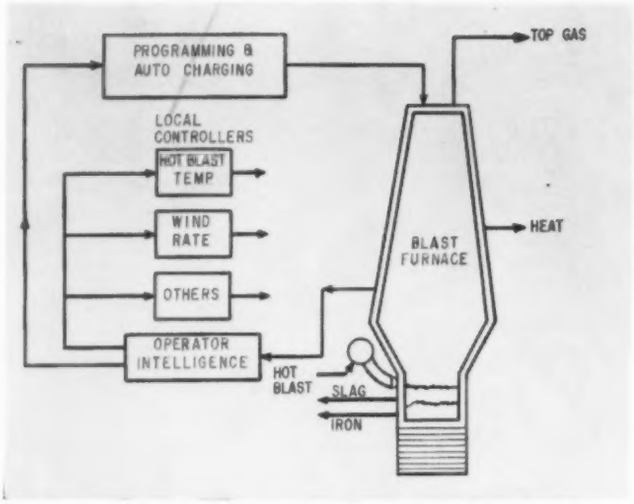
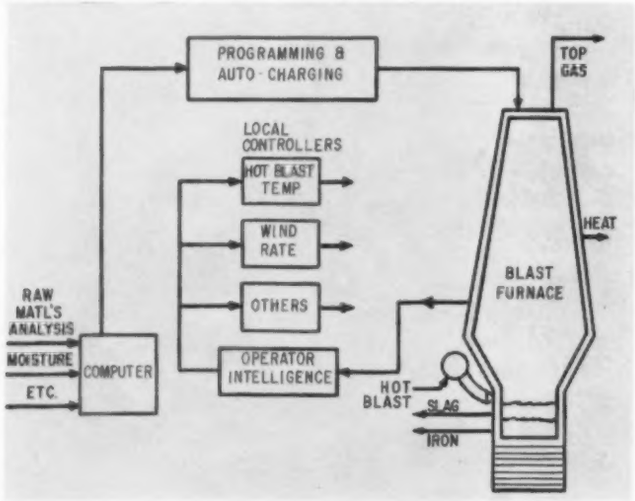


Figure 5 — Most blast furnace control systems contain no feedback control except that interposed by the operator.

terials' analysis, moisture and physical characteristics were held constant, then it would be quite probable that such a weighing system would provide very stable and predictable operation. However, there is reason to believe that raw materials' analysis, moisture and physical characteristics are not constant, and may vary considerably in a short interval of time.

Nevertheless, the blast furnace in itself is a reasonably good averaging device, so these variations in raw materials characteristics do not always result in malfunctioning of the furnace or poor product quality. Furthermore, a capable operator is apparently able to detect changing conditions on the furnace operation and to make compensating adjustments of the various secondary controls available to him, thereby maintaining reasonably stable operation of the furnace. Even so, most operators feel that variations in raw materials, and corresponding inability to maintain constant charge conditions are a significant source of operating difficulty. By this token, there seems to be considerable emphasis on prepared or beneficiated burdens in order to more nearly assure a uniform charge material for the furnace. The steel industry seems to be in unanimous agreement that such efforts are very worthwhile and economically practical, as evidenced by the rapid

Figure 6 — Blast furnace system has automatic charge calculation and reprogramming of charging system.



increase in use of sinter, pellets and sized materials. It might be added that work done on the beneficiation processes has culminated in the installation of a computer/data logging system on a sinter plant recently installed in a midwestern steel plant. However, it should be admitted that the time when the steel industry will be able to produce coke, sinter and pellet products which are absolutely uniform in chemical composition and physical characteristics still has not come, even though great strides are being made in improving these processes.

Accordingly, there seems to be merit in attempting to better control the composite charge going into the furnace by proper blending of the available raw materials, whether the basic material is ore, sinter, or pellets, or all three. It seems logical that more refined charge control should lead to more efficient, more uniform and more predictable operation of the furnace.

While the specific practice for burdening a furnace varies from one plant to another, the over-all impression is that the most common practice is to make an occasional charge calculation on the basis of mine analysis or other rather infrequent analyses of the available raw materials. Once this basic charge is established, it is up to the operator to make the necessary charge and secondary control adjustments to keep his furnace operating smoothly and producing a usable product. It would seem, then, that a more frequent charge calculation based upon current, frequent analyses of the raw materials, and a corresponding adjustment in charge proportions, would do much to stabilize the furnace operation. This is the second step in the evolution of the automated blast furnace (Figure 6).

Earlier three factors which might influence the determination of the correct charge were mentioned: (1) raw materials analysis, (2) moisture content and (3) physical characteristics. No attempt is made to evaluate the relative importance of these three factors, but there is little question that raw materials analysis is an important factor. It has been the primary basis upon which most burden calculations have been made to date.

One of the missing links in realizing more refined burden control has been the lack of a suitable device for accurate, frequent, on-line analysis of the raw materials. Such a device has now become available in the form of an on-line X-ray emission gage. The design of this utilizes the principle of characteristic secondary emission of a sample when exposed to an X-ray beam. This principle has been understood and used for some time. Many engineers are familiar with this technique for quantitative elemental analysis of raw materials through acquaintance with laboratory equipments which have been available for several years. This emission gage operates on the same basic principle as the laboratory device but is designed specifically for on-line operation in the environment of the sinter plant or blast furnace, and designed for continuous analysis of a sample which is fed continuously to the gage. This gage provides for up to five elemental measurement channels plus one reference channel to which the measurement of the five elemental channels are compared to produce a ratio. The ratio is proportional to the per cent of the measured element present in the sample. In other words, the output signals of the

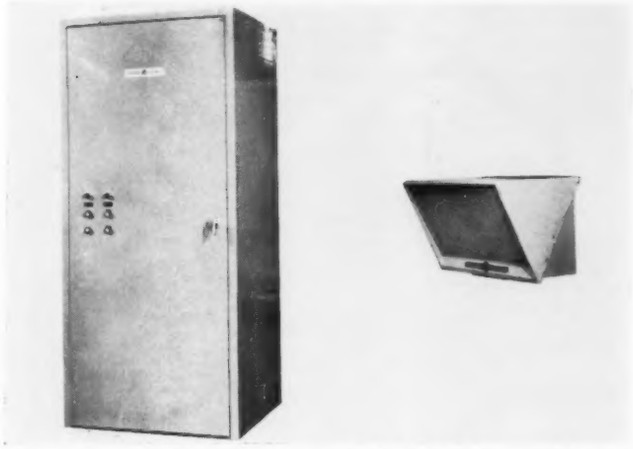


Figure 7 — Continuous raw materials' analyses are being accomplished by X-ray initiated secondary emission.

gage would be proportional to the percentages of the element being measured, such as iron, silicon, etc.

This device cannot be pulled off the shelf, plugged in and made to operate like an electric toaster. Each particular measurement problem requires careful analysis by an X-ray engineer working closely with the user's process engineers in order to determine suitability for that specific situation. However, this device does provide the key to the automation of many of the iron and steelmaking processes. These devices are being applied in sinter plant installations as well as in the cement industry. Figure 7 shows the gage. The cabinet on the left houses the electronic circuits, and the enclosure shown at the right contains the X-ray tube and detecting devices for mounting on-line.

One possible method for utilizing the emission gage to achieve more frequent charge calculation would be to automatically remove a sample from the material charged into each skip. In a conveyorized stockhouse arrangement, this sample might be taken from the stream flowing off the head pulley into a weigh-hopper. The signal taken from the emission gage would be automatically transmitted to a computer/data logger, which would record and store the analysis for that particular charge of material. Similar information would be recorded for each succeeding skip load of material, and accumulated over a period of time (perhaps two, four or eight hr), at which time a charge calculation would be initiated. The computer would then calculate the average analysis for all of the skip loads of like materials, and on the basis of these average analyses of the various raw materials, would calculate new charge proportions. The calculated results would then be automatically transmitted to the programming and automatic charging control and the charging program would be automatically revised to reproportion the materials.

An obvious question arises; i.e., "Are there sufficient benefits from more frequent charge calculations to warrant the use of a rather expensive general purpose digital computer and raw materials analysis equipment?" Needless to say, it is indeed questionable, and most certainly does not utilize the full capability of the digital computer. The question also arises, "Why not use a slide rule or desk calculator to perform these calculations?" The answer to this question is straightforward. If the calculation were to resolve down to being merely a successive series of multiplications, divisions and subtractions which an intelligent operator might perform in a matter of 15 or 20 min, then there is probably little advantage in using a complex device such as a digital computer to perform this calculation. However, the impression is that the simplified charge calculations now made, and the rules of thumb used for modifying the charge are a matter of necessity rather than choice, in order to be sufficiently simple for practical use by an operator. It can be visualized that a charge calculation in its most refined form may involve the simultaneous solution of several multi-variable equations, conceivably factoring in some second or third order effects. Whereas such a complex calculation would be completely impractical for a human being using a slide rule or desk calculator, it should be a rather simple job for the digital computer once the calculating procedure was programmed into the computer memory. Where the calculation might take several hours to perform by hand, the computer might easily perform it in several seconds.

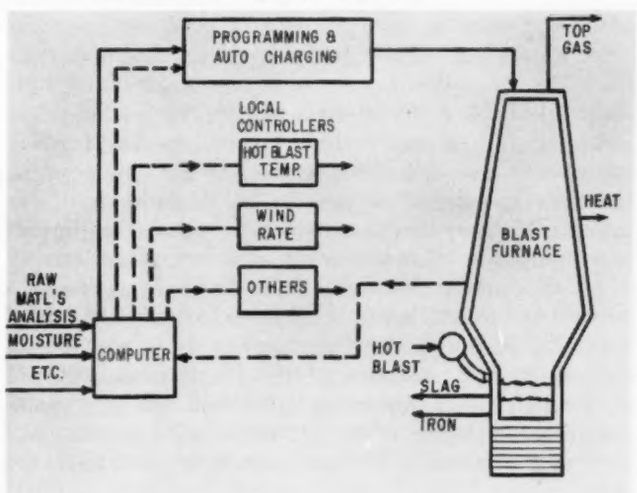
As an illustration of this, while calculations required to select the machine ratings for the adjustable-voltage drives for an ore unloader or ore bridge formerly took a day to a day and a half of an engineer's time, a much more complete calculation is now being peformed by means of a digital computer in about 60 to 90 sec.

Even so, it is doubtful that a digital computer could be justified purely on the basis of performing charge calculations with it. Therefore, it is proposed that the computer be used for other purposes in order to better utilize its capabilities and make it more practical to use.

As for measurement of moisture content and physical characteristics, there is currently a lack of suitable continuous sensing devices. However, moisture measurements may be feasible now on a batch basis with known techniques, and should allow charge calculations to factor in chemical analysis and moisture content.

Ideally, the next step in the evolutionary development of the automated blast furnace system would be to automatically control the various primary and secondary controls in response to variations of certain measured variables on the furnace (Figure 8). A more glamorous terminology for this technique would be "closing the loop." In addition to achieving a more

Figure 8 — The use of a computer for charge calculations, with data feedback from secondary controls, should achieve more precise furnace controls.



refined primary control by means of automatic charge computation, it would appear feasible to achieve more precise control, or vernier control through appropriate action of one or more of the above mentioned secondary controls. It is envisioned that on the basis of the interrelationship between certain measurable process variables, one or more of these secondary controls may be periodically adjusted to maintain a uniform, predictable operation of the furnace.

Obviously, if the system were merely to make a correction by means of one secondary control (such as blast temperature) in straight-line response to one or two measured process variables (such as top temperature or hearth temperature) a conventional analog control system would probably satisfy the desired control function quite satisfactorily. However, it is envisioned that the simultaneous adjustment of several (or all) of the secondary controls may be desirable, the relative magnitude of adjustment of each secondary control being determined by the composite relationship between several measured variables. Furthermore, because of the relatively long time constants between the cause and effect from some of the secondary controls, it is envisioned that the control adjustments will quite probably be periodic rather than continuous. It follows then that the digital computer may lend itself more readily to the solution of these control equations. Is such a complex control system necessary? Discussions with operators would so indicate.

For example, given a certain set of circumstances characterizing a malfunctioning furnace, and presenting the problem to three independent operators for solution, it is quite likely that each operator would come up with his own solution for corrective action. The first conclusion one might draw would be that two of the three operators were incorrect in their solution, but it is not believed this necessarily follows. Perhaps each of them is correct to a degree, and each of them is incorrect to a degree. In other words, there may actually be an optimum correction which would factor in the thinking of all three operators. To correct a hanging tendency, one operator might choose to decrease blast temperature, another might choose to increase moisture and a third might elect to reduce wind. Which is correct? It is also entirely possible that had all three operators agreed that the correct action was to increase moisture, they would have disagreed as to whether they should increase moisture one grain every ten min or five grains and wait for an hr. The point to be made is that sufficient knowledge of the complex process relationships to define the optimum control action under all circumstances of furnace operation is not now available.

This is not to imply that the modern day furnace operator is ignorant of his process or that he lacks an intimate knowledge of the control techniques of his process. Rather, this is a recognition that the process is a composite of many complex relationships, many of which cannot presently be defined precisely in mathematical terms which would allow us to apply automatic control techniques. Furthermore, it is a recognition that successful operation of the blast furnace is still very much a function of operator skill and contains a considerable degree of art. It seems that a stalemate has been reached. The next step toward closing the loop on the blast furnace cannot be taken because

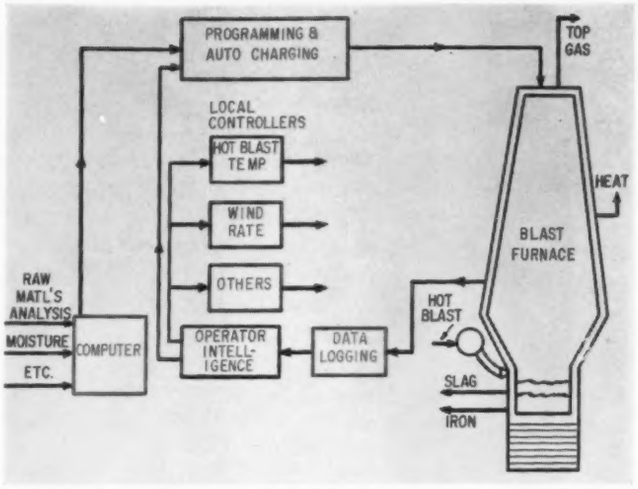


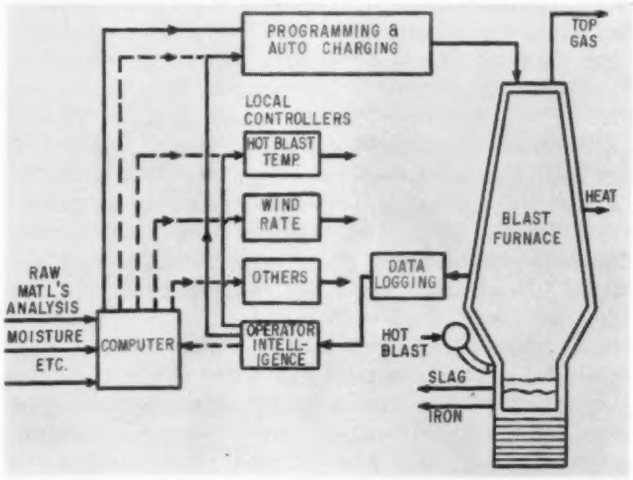
Figure 9 — Computer data logging can assemble the random interval data of the blast furnace.

the dynamic mathematical model representing the complex relationships between the many variables of the process have not been developed.

It would appear that further study and analysis of the process may be required before one can hope to close the loop or so to speak, direct the process. This study and analysis of the process must be well-planned, and must be implemented with a large amount of accurate, organized, time correlated process data. Perhaps then, one can use the digital computer to perform this function of data logging in addition to performing as a charge computer, see Figure 9.

The industrial digital computer, when provided with the proper input and output equipment, is ideally suited to the collection, conditioning and recording of process data on the blast furnace. It has a number of advantages over a conventional data logging system for this particular application. For example in contrast to such processes as the petroleum refining processes wherein practically all of the process variables are continuous in nature and can be scanned at periodic intervals, much of the data which should be recorded on the blast furnace is random in nature. It is data which must be recorded precisely at the time that it becomes available, and cannot be delayed until the scanner has

Figure 10 — The total system would include the ability to expand the system as process analysis develops the control ability for further items.



proceeded through its cycle to that point. Such information as the weight, type and time of each material charge into a skip falls into this category. Also, certain operational events such as the bell openings, the equalizer and relief valve openings and the skip operations occur randomly and must be recorded when the event occurs not at the next convenient scan. Furthermore, there is a need for manipulation of much of the data collected on the blast furnace, such as totalizing, averaging, calculation of ratios, etc. The industrial digital computer can easily accommodate these functions.

The proposed computer/data logger would record data in typewritten form for immediate use by the operator and for daily records, and also on punched tape for permanent records for such things as quality control, production control, accounting, inventory control, etc., plus being ideal for use in process analyses and study programs.

One might argue that such data can be collected by means of much less expensive recording devices; however, it is believed that an objective evaluation of this situation will not bear this out. If the costs of the necessary equipment to record and identify all raw material weights and the type and time of charging, the costs of a strip chart or round chart recording for each continuous process variable which might appear to be important to further analysis of the process and the costs of event recorders to record the time of occurrence of miscellaneous operating events were individually factored. The total cost would be quite comparable to, or greater than, the cost of a computer/data logger. Furthermore, and perhaps of even greater importance, is the fact that the computer/data logger produces the record in a time-correlated form on punched tape, thereby facilitating high-speed reduction of this data by means of scientific computers and other data processing equipment.

In summary, then the proposed approach as shown in Figure 10 would be to design the system to provide for the step-by-step evolution of the ultimate process director system by providing the capability for:

1. Programming and fully automatic charging of all raw materials.

2. Frequent charge calculations by means of a digital computer, based upon frequent raw materials analyses, and including provision for automatic reprogramming of the automatic charging system to maintain, as nearly as possible, a correct charge into the furnace.

3. Collection of time-correlated process data in typewritten form and on punched tape, thereby providing an immediate record for operating purposes, and a permanent record for accounting and inventory purposes as well as for future analysis and study.

4. Set point control of the various secondary or vernier control systems of the process.

5. Expansion of the system, by virtue of the reprogrammability of the digital computer, as process analysis and study leads to the evolution of the complete process director system.

Figure 11 shows the computer/data logger that is proposed as the tool for performing charge calculations, data logging, and process direction. It is a stored program, reprogrammable, digital computer with expandable magnetic drum memory of up to 32,000 words or more, and has been specifically designed for industrial applications of process direction. It is completely transistorized and available with either stepping switch or mercury wetted relay matrix input/output. The computer in Figure 11 is the one which has been installed at the sinter plant mentioned earlier.

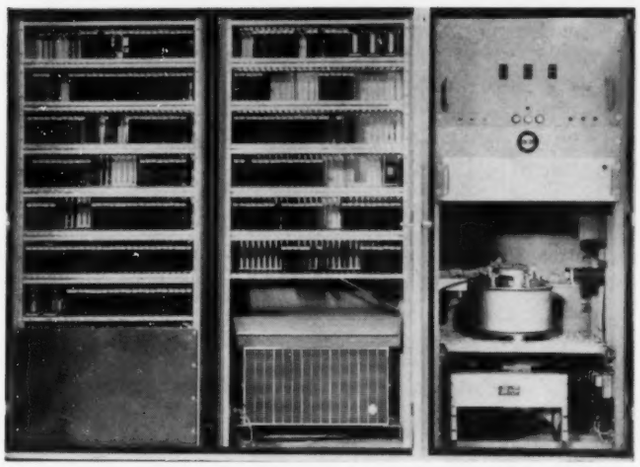


Figure 11 — The computer would be provided with a magnetic memory drum capable of storing 32,000 words.

SUMMARY

An attempt to describe some thoughts concerning a basic approach to the evolution of the blast furnace director system has been made. Perhaps some of these thoughts sound fantastic at first. It will take a company with a spirit of adventure and blessed with a real imagination to make such a venture successful. Nevertheless, such a system is technically feasible today. The next question is, "Can it be economically justified?" In the final analysis, this is a question which you must answer for yourself. In partial reply to this question, it might be asked, "Do you believe that such a system would result in a 5 per cent reduction in coke rate on a blast furnace?" A rather simple calculation would indicate that a 5 per cent reduction in coke rate on a 2000-ton per day furnace would result in a savings of about $420,000 per year in raw materials cost alone. Furthermore, if that 5 per cent coke rate reduction is extrapolated to reflect the resulting increased production, a 4 per cent increase in production would be expected which should result in about $645,000 per year in terms of value of product. The sum of these two figures would indicate that a 5 per cent coke reduction might result in a savings of over $1,000,000 a year. On the other hand, if the best guess was that such a system might result in only a 1 per cent reduction in coke rate, then the resulting value would be reduced proportionately to perhaps over $200,000 per year.

Other benefits which should result from such a system are: (1) improved accounting and inventory records, (2) improved predictability and uniformity of furnace operation through elimination of some of the human element involved in controlling the furnace, (3) better data available to the blast furnace operator as an aid in his every-day operations and (4) the capability and flexibility which will allow expansion of the system to encompass the concept of process direction as knowledge allows. Here again, it is operating management who is in the best position to determine the value of these factors in any operation. ▲

The Venturi Scrubber for Cleaning Oxygen

by HOWARD P. WILLET
Manager
and DANIEL E. PIKE
Gas Scrubber Div.
Chemical Construction Corp.
New York, N. Y.

. . . . because of the increasing usage of the basic oxygen processes and the expanded use of oxygen in open hearth production, waste gas cleaning has become an important factor in the economic operation of a steelmaking plant . . . .

THE gas cleaning problem accompanying the L-D oxygen steel process is a difficult one due to the extremely small particle size of the fume and the intermittent blowing of oxygen which causes a varying temperature. A venturi scrubber system will effectively clean the gases and provide the reliability required for a steelmaking operation of this kind. Until recent times little was known about sizing gas cleaning plants and the efficiencies required. This article presents a method for sizing gas cleaning plants, and a description of a new venturi gas cleaning system incorporating all of the data and experience gained to date, with a discussion of the factors involved.

GENERAL ASPECTS

The gas cleaning system—The object of the gas cleaning plant is to ventilate the furnace and discharge a clean gas to the atmosphere in a dependable and economical manner. In the steel industry, the accent is on production and therefore the gas cleaning plant should in no way interfere with the steelmaking operation. A malfunction of the gas cleaning plant will result in lost production or venting of the dirty gas to the atmosphere, either of which is intolerable. Therefore, extreme reliability is of the utmost importance. The gas cleaning system starts with the hood over the furnace and ends with the final stack discharging clean gas to the atmosphere. The hood is a vital part of the system since it dictates, to a large extent, the capacity requirements.

The dust—The particle size and chemical composition of the fume have adequately been given in the literature, and it will suffice here to say that it is composed essentially of Fe_2O_3 with a small amount of FeO and Mn_3O_4.[1]* There are also traces of the oxides

* Numbers in parentheses refer to Bibliography at end of article.

TABLE I
Waste Gas Volume and Composition

Combustion air, per cent	Excess air, per cent	Waste gas, cu ft per cu ft of O_2					Induced air, cu ft per cu ft of O_2	Waste gas composition, at peak of blow, per cent				Estimated hot gas temperature, F
		CO	CO_2	N_2	Air	Total		CO	CO_2	N_2	Air	
0	. . .	2	0	0	0	2	0	100	0	0	0	3000
25	. . .	1.5	0.5	0.94	0	2.94	1.19	51	17	32	0	3500
50	. . .	1	1	1.88	0	3.88	2.38	25.8	25.8	48.4	0	3800
75	. . .	0.5	1.5	2.82	0	4.82	3.57	10.4	31.1	58.5	0	4000
100	0	0	2	3.76	0	5.76	4.76	0	34.7	65.3	0	4200
125	25	0	2	3.76	1.19	6.95	5.95	0	28.8	54.1	17.1	3600
150	50	0	2	3.76	2.38	8.14	7.14	0	24.6	46.2	29.2	3200
175	75	0	2	3.76	3.57	9.33	8.33	0	21.4	40.3	38.3	3000
200	100	0	2	3.76	4.76	10.5	9.52	0	19.0	35.8	45.2	2700
300	200	0	2	3.76	9.52	15.3	14.3	0	13.1	24.6	62.3	2000
400	300	0	2	3.76	14.3	20.1	19.1	0	10.0	18.8	71.2	1600
500	400	0	2	3.76	19.0	24.8	23.8	0	8.1	15.2	76.7	1300
600	500	0	2	3.76	23.8	29.6	28.6	0	6.8	12.7	80.5	1100

Steel Process Gases

of silicon, calcium, aluminum and phosphorus. The particle size is very minute, the fume containing 85 per cent by weight of particles less than 1.0 micron in diameter and 20 per cent less than 0.5 micron.[2] By comparison, gas molecules are just under 0.01 micron. From existing installations it is known that the total amount of dust given off represents not more than two per cent of the weight of the metallic charge.[3] The dust loading varies considerably during the oxygen blowing period and reaches a maximum after CO evolution begins, when the temperature is highest.

The CO which is formed leaves the mouth of the furnace and carries with it droplets of slag and iron, FeO fume and vaporized iron.[3] The FeO is characterized by the dark brown color of the gas at the mouth of the furnace. When this mixture reaches the hood, it mixes with induced air and is burned. The CO goes to CO_2, and the vaporized iron and FeO to Fe_2O_3 fume, which gives the gases their typical reddish brown color. The larger droplets of iron and slag fall back to the ground under the furnace and the smaller droplets solidify to form what is called "shot" which is carried up into the stack with the hot gases. This shot settles rapidly in flues and ducts and means of removal must be provided.

The waste gas—The gas emanating from the mouth of the furnace is essentially CO and is burned in the hood with induced air. The combustion products are referred to as the waste gas rather than the CO from the furnace. The final volume and temperature of the hot waste gas varies with the amount of CO evolved. The temperature reaches a peak, which could melt refractory lining if uncontrolled, and then falls off at the end of the blow. The hood should be arranged so that no waste gas or CO escapes collection and that a predetermined or controlled amount of air is induced into the system for combustion purposes.

Waste gas volume and temperature—The process should be examined to determine what occurs in the furnace and in the hood. Insofar as the gas cleaning plant is concerned, the fundamental reactions are as follows:

$$2\ C\ (\text{in metal}) + O_2\ (\text{lance}) \rightarrow 2\ CO\ (\text{in furnace})$$

$$2\ CO + O_2\ (\text{from air}) \rightarrow 2\ CO_2\ (\text{in hood})$$

Actually the gas from the mouth of the furnace contains approximately 90 per cent CO and 10 per cent CO_2, but to be conservative it will be considered pure CO. It is generally desirable to burn all of the CO to CO_2 in the hood; therefore, the hood should be treated as a combustion chamber. With a venturi scrubber system, however, it is by no means essential to burn all of the CO, since a wet system can tolerate a considerable amount of CO without danger of explosion. It is desirable and, in fact, mandatory to arrange the hood so that a controlled or limited amount of air is induced for combustion purposes. In this regard, the following combustion equations are evolved:

With no excess air:

$$2\ CO + \underbrace{O_2 + 79/21\ N_2}_{\text{4.76 Combustion air}} \rightarrow \underbrace{2\ CO_2 + 3.76\ N_2}_{\text{5.76 Waste gas}}$$

With 50 per cent excess air, 150 per cent combustion air:

$$2\ CO + \underbrace{O_2 + 79/21\ N_2}_{\text{4.76 Combustion air}} + \underbrace{2.38\ \text{Air}}_{\text{50 per cent Excess air}} \rightarrow \underbrace{2\ CO_2 + 3.76\ N_2 + 2.38\ \text{Air}}_{\text{8.14 Waste gas}}$$

With only 50 per cent combustion air:

$$2\ CO + \underbrace{\tfrac{1}{2}\,[O_2 + 79/21\ N_2]}_{\text{50 per cent Combustion air}} \rightarrow \underbrace{CO + CO_2 + 1.88\ N_2}_{\text{3.88 Waste gas}}$$

For other amounts of combustion air, Table I gives the waste gas composition and volume. The hot gas temperatures given in Table I have been estimated from existing installations under conditions where no water was sprayed into the hood.[3, 6, 7]

Gas cleaning requirements—In a venturi system the gas cleaning efficiency depends solely on the pressure drop available for scrubbing, which includes the pressure drop over the quencher and venturi. Figure 1 shows the performance of the venturi scrubber on oxygen steel waste gases and was obtained from tests on the gas cleaning plants at Algoma Steel Corp. and Dominion Foundries and Steel, Ltd. Outlet concentration in terms of grains per std cu ft of dry gas at 60 F and 14.7 psi is plotted as a function of venturi pressure drop.

TABLE II
Values of Dust Concentrations in Stack Gases*

Grains per std cu ft of dry gas plus water vapor at temperature indicated	
0.046	110 F saturated gas
0.039	145 F saturated gas
0.025	180 F saturated gas
0.038	500 F 75 per cent dry gas, 25 per cent water vapor
Grains per cu ft of dry gas plus water vapor at temperature indicated	
0.042	110 F saturated gas
0.034	145 F saturated gas
0.020	180 F saturated gas
0.020	500 F 75 per cent dry gas, 25 per cent water vapor

* Equivalent to 0.05 grain per std cu ft of dry gas at 60 F and 14.7 psia.

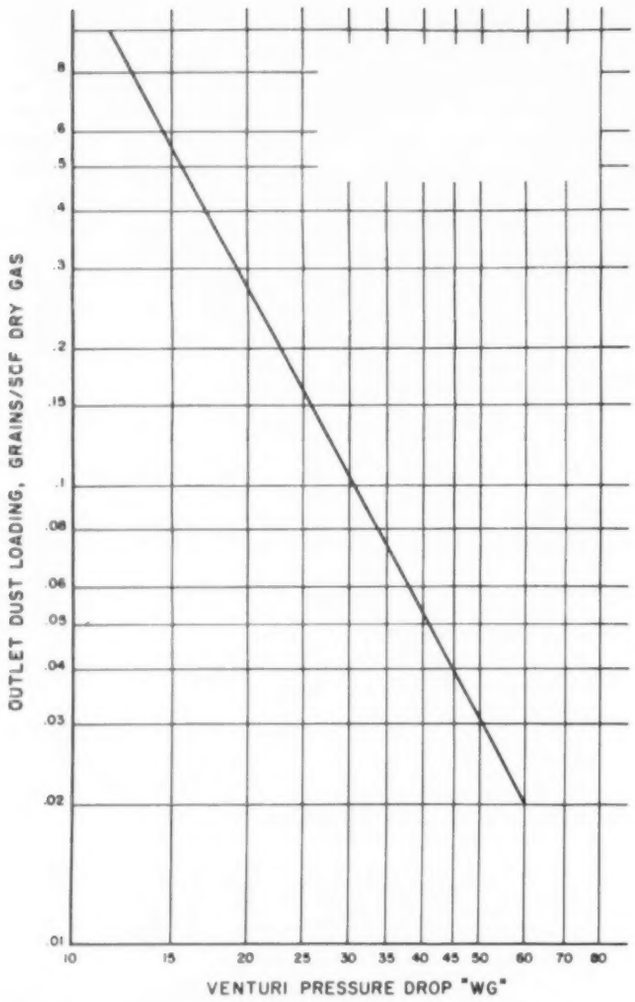


Figure 1 — The cleaning efficiency of the venturi system is a function of the available pressure drop.

Since there frequently is a considerable amount of confusion in reporting dust loadings, Table II is presented to show dust concentrations equivalent to 0.05 grain per std cu ft, dry, and to give an understanding of concentrations on wet and dry bases. In industry this value is generally considered to give a clean stack appearance.

To determine the required gas cleaning efficiency and outlet concentration, several items must be considered:

1. Present and future requirements of air pollution codes.
2. Proximity of residential areas.
3. Meteorological conditions.

An L-D plant operating one furnace at a time and blowing 8000 scfm of oxygen will be considered as an example. Suppose that a residential area is nearby and that the prevailing winds are in that direction. Furthermore, assume that the local code limits the discharge to 40 lb per hr (Los Angeles requirements). Since the oxygen blowing period is generally one half hr out of every hr, the plant will be allowed to discharge 40 lb in a half hr or a rate equivalent to 80 lb per hr during oxygen blowing. For 65,100 scfm waste gas, this is equivalent to 0.14 grain per std cu ft, dry.

However, experience indicates that a dust concentration of 0.14 grain per std cu ft, dry, will present a pink color in the stack gas and the probability of neighborhood complaints may be high. Therefore, more efficient cleaning may be desired. For a clean stack appearance the concentration should be limited to 0.05 grain per std cu ft, dry, and since this is less than half of the 0.14 grain per std cu ft, dry, required by the code (for one furnace), they could blow two furnaces alternately using only one gas cleaning plant and still meet the code. From Figure 1 it can be seen that an effluent with 0.05 grain per std cu ft, dry, requires a pressure drop of 41-in. water column for scrubbing.

VENTURI SCRUBBER SYSTEM

Described below is a new venturi system (Figure 2) incorporating the best features of all existing installations. In addition three new power saving features are included:

1. Induced air is limited to that required for combustion as discussed above.
2. Water vapor is condensed from the cleaned gas to reduce gas volume at the fan.
3. Gas and water flows are throttled between heats.

Capacity requirements—For this system the capacity was determined assuming no CO in the waste gas and 50 per cent excess air. Specifications would be:

Furnace capacity . . . 160 tons
Plant capacity . . . . . 1,200,000 ingot tons annually
Oxygen rate . . . . . 8000 cfm
Waste gas volume . . . . . .
. . . . . 8.14 cu ft per cu ft of oxygen (from Table I)

$8000 \times 8.14 =$
65,100 scfm of dry gas at 3200 F (from Table I)

Saturated gas volumes:

Venturi inlet	177,000 cfm at 183 F, 14.7 psi
Fan inlet	91,000 cfm at 110 F, −52-in. water gage
Fan outlet	80,000 cfm at 110 F, 14.7 psi

Static pressure distribution, in. water gage

Quencher	4
Venturi	41
Gas cooler	5
System	2
Fan static pressure	52

It should be pointed out that the waste gas does not behave as air since it contains 24.6 per cent CO_2 which has a much higher heat capacity than air at elevated temperatures. Therefore, ordinary psychrometric charts should not be used. A total of 50 per cent excess air was specified so that no CO would be discharged to the atmosphere even though this could be accomplished with less excess air. In effect an allowance was made for a future increase in oxygen blowing rate. In other cases the system might be sized to limit the CO concentration to approximately 12 per cent, the lower explosive limit, or to permit infiltration of the minimum amount of induced air through a fairly tight hood with no limit on CO concentration.

The capacity of a venturi gas cleaning plant can be determined on the basis of hood arrangement and materials of construction suitable for the hot gas tempera-

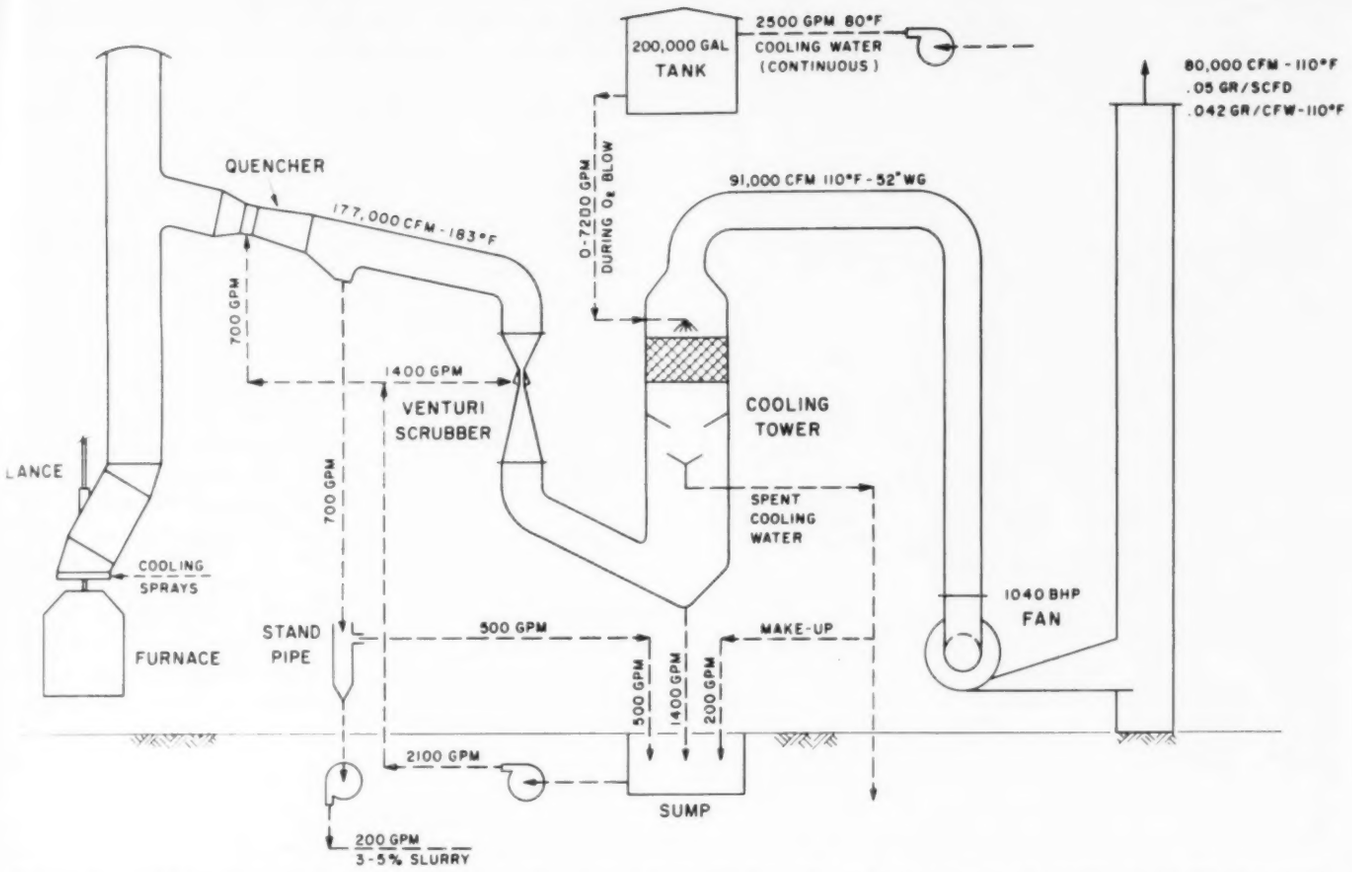


Figure 2 — The venturi gas cleaning system is shown in schematic form for a basic oxygen plant blowing 8000 cfm of O_2.

ture, rather than by CO limitations and explosion hazards.

It is felt that 50 per cent excess air provided enough safety factor for abnormal heats and future increases in the oxygen blowing rate. With no excess air up to 11,000 cfm oxygen could be blown.

The gas volume at the fan inlet is less than half of that at the venturi inlet. This is accomplished in the cooling tower by condensing the water vapor and lowering the temperature. This feature drastically reduces fan power and virtually eliminates the steam plume.

Power consumption—A fan to deliver 91,000 cfm at 52-in. water gage static pressure and 110 F will require 1040 bhp if the fan efficiency is 72 per cent. Fans with efficiencies up to 86 per cent are available from several manufacturers and several European oxygen steel plants are now operating with these high efficiency fans. Assuming that the fan and cooling water pump are throttled between heats, the average power requirement is as follows:

Item	*Hp*
Fan	695
Recirculating pump	165
Cooling water pump	100
Slurry pump	10
	970 = 724 kw

Water requirements—The water consumption is held to a minimum by a unique water recirculation system. Scrubbing water is recirculated to the quencher and venturi scrubber from a common sump. The quencher water, which contains the larger dust particles and "shot," drains to a standpipe. This allows the heavier solid material to settle while the thin slurry overflows back to the sump. The solids at the bottom of the standpipe are continuously pumped away together with enough water to make the slurry pumpable and to provide sufficient bleed from the system to remove soluble and colloidal matter. The venturi requires eight gpm of recirculated water per 1000 cfm of saturated gas passing through it and the quencher four gpm per 1000 cfm.

A varying amount of cooling water is required for the cooling tower since the hot gas temperature varies from ambient to 3200 F. For approximately 15 of the 30-min blowing time 7200 gpm of cooling water are required. No cooling water is required for the first three or four min. It is calculated that one complete cycle requires 150,000 gal of cooling water, which can be accumulated over a period of one hr at a rate of 2500 gpm. Since the cooling water contacts only cleaned gas, it picks up little dust and may be discharged to any sewer or river without treatment.

The water evaporated in the quencher is condensed in the cooling tower and leaves the tower with the spent cooling water, part of which is used for make up. Only a small amount of water is discharged to the atmosphere since the final gas temperature is 110 F. Thus the steam plume is largely eliminated.

Sludge removal—The collected dust (approximately 13,500 tons per year) leaves the scrubber in a 200-gpm stream of three to five per cent slurry. This slurry may be handled in three ways.

1. The slurry may be pumped to an existing thick-

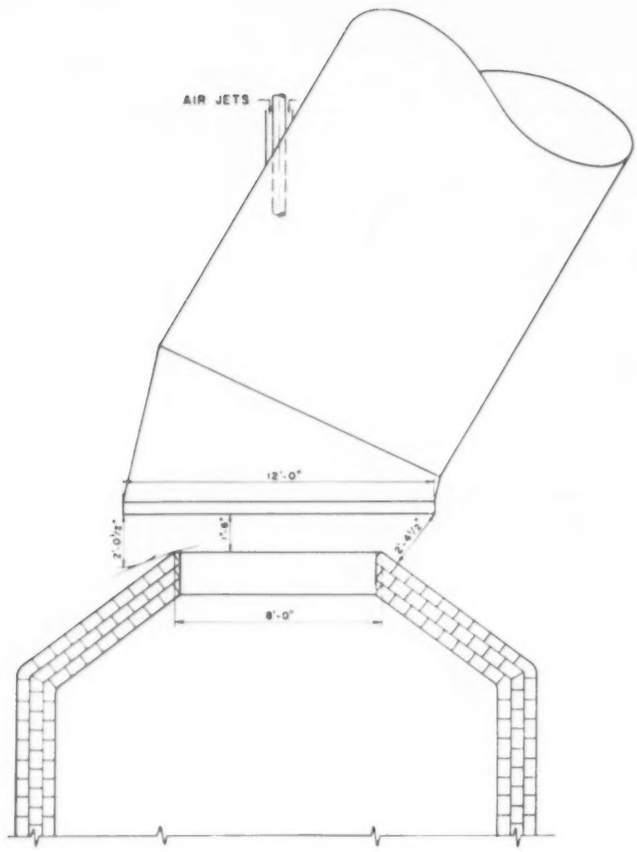


Figure 3 — Design of the furnace hood is an important factor in the control of gas volume and temperature.

ener where it is treated with waste from other parts of the steel mill. This is the most convenient method and is also the most economical if it is not desired to recover the dust.

2. The slurry may be treated in a centrifuge to give a centrifuge cake containing 12 per cent water. The centrifuge effluent is clean enough to be sewered in many cases or it may be returned to the scrubbing system.[4]

3. The slurry may be treated in a conventional thickener and filter to give a cake containing 25 per cent water. The filtrate would be returned to the thickener and the thickener overflow would be sewered.

The cake obtained (see 2 and 3 above) can readily be converted into a suitable furnace burden by pelletizing, briquetting or extruding.[1]

Hood design—With the above example in mind, the conditions prevailing at the mouth of the furnace and the hood can be examined. The amount of induced air is (using Table I):

$$7.14 \times 8000 = 57{,}000 \text{ scfm}$$

With the hood arrangement shown in Figure 3, the open area is that of a cone with a slant height of 2 ft-4½ in. and is calculated to be 75 sq ft. On this basis the air velocity between the hood and furnace is 760 fpm which is considerably more than recommended for most industrial hoods. A clearance in excess of two ft is provided to prevent the slag buildup from interfering with the hood when the furnace is tilted. The most recent trend in hood design is to make the shape of the hood approach the shape of the furnace mouth as closely as possible. The lance hole may have reverse air jets to prevent gas from escaping.

COMPARISON WITH ELECTROSTATIC PRECIPITATOR

The choice of a gas cleaning system for an oxygen steel plant usually is reduced to either a venturi scrubber or an electrostatic precipitator. In making the choice all elements of cost for the entire system, including the hood, quencher, gas cleaner, ductwork, real estate and dust recovery system, must be considered.

A summary of most of the cost elements for an electrostatic precipitator[5] is given in Table III together with the venturi system both with and without a sludge treatment plant.

Not reflected in the costs given in Table III are certain intangible differences in the two cleaning methods which should not be overlooked. Some of the more important differences will be examined.

The hood and stack of a venturi installation will be smaller. Due to the larger gas volume of a precipitator installation one would expect the temperature to be lower. In actual operation water is sprayed into the hoods of both systems and the final hot gas temperature depends a great deal more on the amount of water sprayed than on the cooling effect of the induced air.

TABLE III
Summary of Economics①

Type of system	Electrostatic precipitator	Venturi scrubber With sludge treatment	Venturi scrubber Without sludge treatment
Final form of dust	Dry, pugged with 12 per cent H_2O	Pellets	Pumpable slurry, five per cent H_2O
Erected cost	$1,940,000②	$1,200,000	$950,000
Capacity, std cfm of dry gas	197,000	65,100	65,100
Average dust emission during O_2 blow, lb per min	1.5	0.47	0.47
Costs			
Power③	$ 75,600	$ 78,000	$ 61,000
Operating labor	32,500	32,500	11,000
Maintenance④	58,200	36,000	28,500
Depreciation⑤	97,000	60,000	47,500
Interest and real estate⑥	97,000	60,000	47,500
Total annual cost	$360,300	$266,500	$195,500
Cost per ingot ton	$0.30	$0.22	$0.16
Value of recovered dust	$95,000⑦	$162,000⑨	$67,500⑧
Net annual cost	$265,390	$104,500	$128,000
Net cost per ingot ton	$0.220	$0.087	$0.107

① L-D gas cleaning plant for one 160-ton furnace blowing 8000 cfm of O_2, equivalent to 1,200,000 ingot tons per year, at 22 heats per day, 350 days per year.

② Including spark box and duct to precipitator, $4 per cfm × 485,000 cfm = $1,940,000.[2]

③ Power cost assumed to be $.01 per kw.

④ Maintenance estimated at 3 per cent of installed cost.

⑤ Estimated at five per cent of installed cost.

⑥ Real estate tax of 2.5 per cent and interest rate of 2.5 per cent of installed cost.

⑦ Cost of pelletizing dust pugged with 12 per cent water is estimated at $5 per ton of pellets. Assuming pellets are valued at $12 per ton at the plant, the value of the pugged dust is $7 per ton. For 13,500 tons of dust this is $95,000.

⑧ Cost of pelletizing dust from five per cent slurry is approximately $7 per ton. With pellets at $12 per ton, the value of the slurry is $5 per ton of dust; therefore, 13,500 tons are valued at $67,500.

⑨ With pellets at $12 per ton, 13,500 tons are valued at $162,000.

The relative merits of a spark box vs a quencher show up in the manner of operation. A spark box is usually a large chamber with spray nozzles whereas a quencher is essentially a low velocity venturi. The former cools the gas to only 500 F, whereas the quencher cools the gas to its saturation temperature. The quencher eliminates most of the operating difficulties usually associated with spark boxes since the relatively high water rates used in the quencher help to keep the equipment flushed and reduce deterioration due to high temperatures. The quencher requires no sensitive temperature control device and there are no spray nozzles to plug.

One of the important differences in the two cleaning methods is the manner in which the dust is processed after removal from the gas stream. In a precipitator the dust is collected dry in hoppers beneath the precipitator chambers. The difficulty comes in trying to transfer this material to cars or in trying to wet it to prevent further dusting. At least one shop is currently wetting the dust in a specially designed apparatus and pumping the slurry to a thickener. It is the general opinion of operators that the dry dust must be pugged or wetted for successful handling. By contrast, when the dust is originally collected as a water slurry in the venturi scrubber, it never again becomes a source of secondary air pollution. Conventional techniques can be used to recover the dust in an extruded or pelletized form.[1,4]

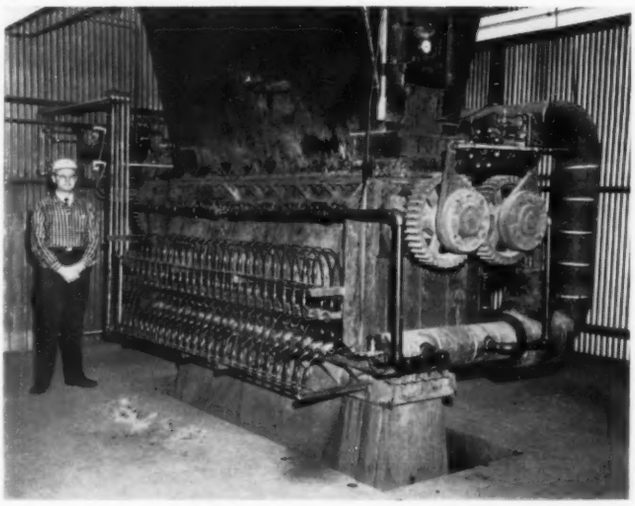
Simplicity of operation and freedom from operating maintenance are two prime prerequisites of any steel plant equipment. By nature, precipitators are complicated mechanisms. Constant attention must be given to such things as maintaining proper moisture conditioning of the gas, avoiding gas flows greater than design, maintaining rapping mechanism and removing dry dust from hoppers. There are over 60 venturi scrubbers on installations cleaning blast furnace and oxygen converter gases, and requiring little or no attention.

Where space is at a premium, a venturi scrubber can be installed in about ten per cent of the area required for a precipitator, see Figure 5.

A precipitator system discharges a stack gas with a dust concentration of 0.022 grain per cu ft, wet at 500 F and the venturi 0.042 grain per cu ft, wet at 110 F. However, it is interesting to note that the final dust concentration is 0.05 grain per std cu ft, dry, in both cases and the total dust emission of the precipitator installation is 1.5 lb per min compared to 0.47 lb per min for the venturi system. This is due to the much larger precipitator gas volume. Many air pollution codes specify discharge rate in terms of lb per hr rather than grains per cu ft.

Comparing fans of the two systems, it can be seen from the example given and from reference[5], that a precipitator installation has two fans handling a total of 485,000 cfm of gas at 500 F and 10-in. static pressure compared with one fan for 91,000 cfm at 110 F and 52-in. static pressure for the venturi. Although the precipitator fan handles a much larger gas volume, the static pressure is less and therefore the power requirement of both systems is about the same.

Figure 4 — The throat of this venturi scrubber is automatically varied to provide maximum efficiency for any gas volume up to 180,000 cfm.



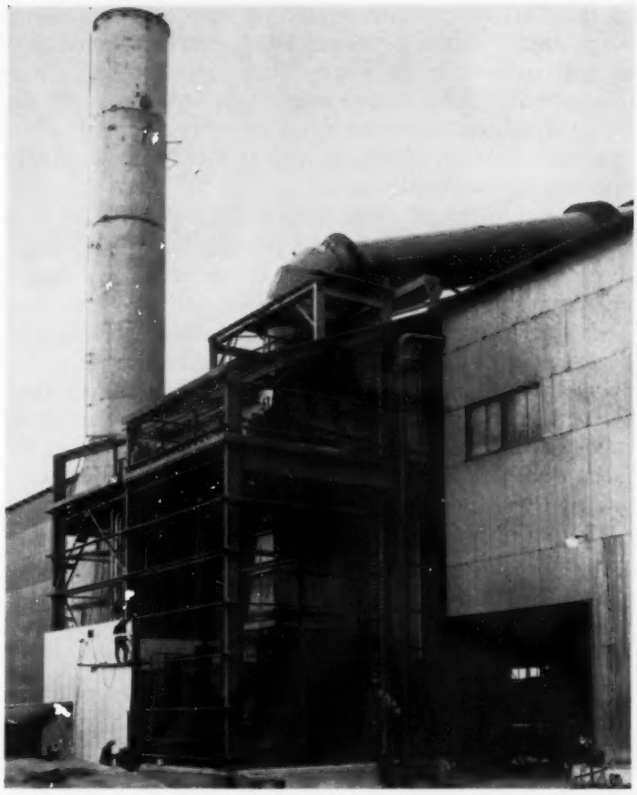


Figure 5 — The over-all size of the venturi scrubber is less than that of the electrostatic precipitator.

BIBLIOGRAPHY

1. "Pelletizing Tests on an Oxygen Converter Sludge," Chemical Construction Corp., Gas Scrubber Div., 320 Park Avenue, New York 22, N. Y.
2. "Dust Removal Plant at the Bochumer Verein L-D Steelworks," by A. Harr, et al., Berg- und Huttenmann Monatshefte, Vol. 104, 1959. (Brutcher Translation 4717).
3. "The Waste Gas Problem in Oxygen Steel Production, Especially the L-D Process," by K. Baum, Berg- und Huttenmann Monatshefte, Vol. 104, 1959. (Brutcher Translation 4717).
4. "Test of a Continuous Centrifuge on the Slurry from a Chemico Venturi Scrubber in an Oxygen Steel Plant," Chemical Construction Corp., Gas Scrubber Div., 320 Park Avenue, New York 22, N. Y.
5. "Gas Cleaning," by R. G. Gaw, 1960 AISE Proceedings, p. 741.
6. Plant Visit, C. C. Benton, et al., Algoma Steel Corp. Ltd., Saulte Ste. Marie, Ontario.
7. Plant Visit, D. O. Davies, et al., Dominion Foundries and Steel, Ltd., Hamilton, Ontario. ▲

New Methods of

METHODS of overcoming crane rail mounting maintenance problems have been developed and proved in service in heavy duty steel mills. These methods involving continuous rails, soft mounted on grooved rubber pads and fixed by spring clips, lead to smoother running of cranes, with reduced impact effects and ease of track realinement.

The mounting of crane rails on runway beams has caused problems for the maintenance engineer ever since the overhead traveling crane was introduced into the steel mill. These problems are well known. They include loosening of the rail fastenings followed by fatigue failure through the connecting rivets, bolts or welds, wear of the rail into the top flange and wear of the rails at rail joints. These troubles are sometimes followed by loosening of rivets and plates followed by fatigue in riveted girders and fatigue failure in welds and plates of welded girders.

There are two main reasons for these problems. First, the rail is resting on a surface which changes in length as the crane moves along, due to normal structural action of the runway beam. This is the essential difference between overhead track and ground track. The second reason is that the rail tries to lift up from its support ahead of each loaded wheel as it rolls along giving rise to the well known "bow-wave" effect. The first of these effects leads to loosening of the rail attachments followed by fretting wear of the girder flange and the second causes fatigue in the attachments after they have worked loose.

Deterioration of rail joints leads to hammering from the crane wheels with impact effects on the crane, the runway and the columns, and after a time the rails have to be changed or shortened. Impact effects, especially, can lead to damage to the runway beam in the form of loosening of rivets and fatigue cracking of welds. Also, the heavy concentrated loads which bear on to the girder under the wheels cause secondary stresses which can lead to similar damage. Eventually repairs of this sort can be very expensive.

With the conventional rail fixing methods using solid clips or bolts or rivets, sooner or later these troubles appear and once started, are rarely cured. When the rail is left loose between locating angles, fretting and wear takes place and the risk of a crane derailment occurring at a broken rail is increased. Piecemeal attempts to rectify one or more of these troubles often intensify the others with no resulting gain. For example, welding of track into continuous lengths over simply supported girders prevents rail joint knock but results in more rapid loosening and fatigue of the rail fastenings and often causes rails or rail welds to break near the joints between the girders. Maintenance of track in busy steel mills can be, therefore, both difficult and expensive. Adjustment to track gage is impossible with some types of fixing and is often made impossible with others by the groove worn into the top flange by the rail. Accordingly, rail changing when the rails are worn can be a major operation since the runway must often be repaired before the new rail is fitted.

An intensive study of the post-war problem in the United Kingdom has led to the belief that there are two fundamentally different ways of approaching the problem. Either the rail should be fixed so firmly to the runway that it acts as part of the girder flange or alternatively it should be allowed to breathe with respect to the girder, leading to longitudinal sliding movements at every crane pass. In the first case, which has been called the fully hard method of fixing, the fastenings must be strong enough to resist the heavy horizontal shear forces which develop between the girder flange and the rail and must never loosen or fail in fatigue. In the typical case of a 175-lb per yard rail having a sectional area of 16 sq in. connected to a girder flange stressed to 11,200 psi, this shear force can be 88 net tons and this has to be transmitted to the girder over a short length at the end of the rail.

In the second case, which has been called the fully soft method, the fastenings must be flexible enough to allow movement of the rail with respect to the girder without loosening or fatigue. As an example of the movement to be accommodated, a 50-ft span girder having a mean flange stress of 11,200 psi under load changes in length by approximately ¼ in. as the crane passes over. In addition means must be introduced to prevent fretting wear of the rail on the flange and the rail joint problem must be overcome.

The normal fixing methods, such as riveting or bolting, or bolted or welded clips, are usually neither strong enough to resist the forces involved, nor flexible enough to remain tight. The usual pattern of failure is that the end fastenings which receive the heavy shear forces work loose first, leading to fatigue followed by fretting wear in the girder. Progressive failure of the

Figure 1 — In the hard method of rail fastening, the rail is held against the cover plate, or girder, by a heavy spring clip.

Mounting Crane Rails On Overhead Runways

by A. GORDON SENIOR
Senior Research Engineer
W. S. Atkins & Partners
Consulting Engineers
London, England

. . . . methods of overcoming crane rail mounting maintenance problems have been developed and proved in service of heavy duty steel mills . . . these methods involving continuous rails, soft mounted on grooved rubber pads and fixed by spring clips, lead to smoother running of cranes, with reduced impact effects and ease of track realinement . . . .

fastening from the ends of the rail to the center follow in the zip unfastening manner which is well known to maintenance engineers.

Successful fully hard and fully soft methods of fastening have now been developed and proved in the laboratory and in service. These are both comprehensive systems which combat all the usual maintenance problems. Both involve the use of spring clips, welded studs and a continuously welded rail and the soft method introduces a cushioning pad of rubber between the rail and the girder. They may be used on either simply supported or continuous girders.

The hard method of fastening is shown in Figure 1.*

* Photographs are reproduced by courtesy of the Steel Co. of Wales, Ltd.

Figure 2 — The spring clip used in the soft method of rail fastening is more flexible, permitting rail movement in all directions.

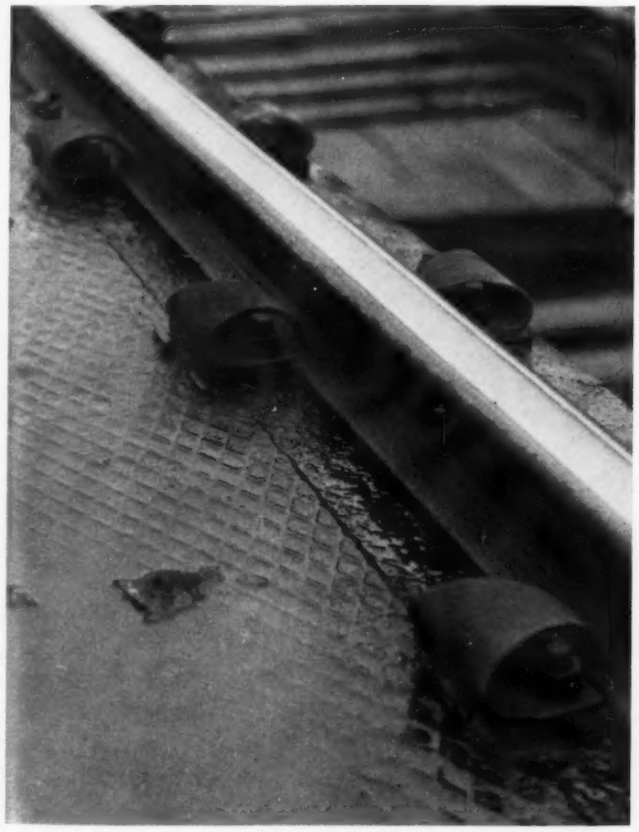


Figure 3 — A molded rubber pad is used to cushion the shock loading and prevent erosion of the cover plate caused by rail movement. Location lugs molded on the rubber pad can be seen at the edge of the rail base.

Here the type 1 spring clip made from heat treated spring steel is cambered in two directions and designed to give the maximum clamping force within reasonable proportions consistent with some flexibility. When fully tightened it exerts a clamping force of 8960 lb with a nose deflection of $\frac{3}{16}$ in. An equivalent clip of mild steel to give the same clamping force would be insufficiently flexible to remain tight in service. This clip is suitable for use with the smaller crane rails where it constrains the rail to be stressed with the girder by means of friction developed between them. It can also be used as a very cheap method of fixing heavy rails in buildings where the crane duty is low such as in motor rooms.

The soft method of fastening shown in Figures 2 and 3 can be applied to light, medium or heavy crane track. The type 2 spring clips shown are produced in three sizes to suit different rail sections and are sufficiently resilient to allow movement of the rail in all directions with respect to the runway without any loss of clamping force and without loosening and fatigue failure of either the clip or its fastening. The fatigue endurance of the clip with the nose deflected in all directions has been established by extensive laboratory tests. The clips may be fixed to the girder flange either by welded studs or by mild steel bolts. On continuously welded runways where tensile stresses arise in the top flange over the columns, a special machined, welded stud has been developed and fatigue tested as a safeguard against any defect, though unlikely, in the stud weld leading to fatigue fracture of the girder plate.

The continuous rubber pad is generally $\frac{1}{4}$-in. thick with longitudinal grooves and having one of several special profiles developed to meet different conditions. A typical profile is crowned to accommodate the average concavity of rail flanges and grooved to provide a mounting which is soft enough to bed the rail closely to the flange under the clipping force but hard enough to transmit the heavy wheel loads when the grooves have closed solid. The pads are made of synthetic polysar rubber impervious to oil and sunlight, highly resistant to sliding wear or scuffing and capable of being used at continuous operating temperatures up to 200 F. For applications where continuous higher temperatures are encountered silicone rubbers can be used.

The rubber pad is also effective in reducing substantially the local stress effect in the top flange and web of girders and reducing the likelihood of fatigue damage. In conjunction with the butt welding of rails which is done with a puddle arc welding process using standard mobile welding equipment, the impact effects in the girder from crane motions are reduced to less than five per cent. On new buildings advantage can be taken of this at the design stage with economy in the weight and cost of both structure and foundations.

Both types of spring clip, the machined welded stud and the rubber pad are being widely used in steel mill buildings in the United Kingdom. After five years service in very heavy duty mill buildings both systems have proved to be wholly successful. All the components are covered by patents.

It should be clearly understood that the best technical solution is not necessarily the best economic solution. The plant manager is concerned with the latter which only emerges after a comparison of the relative costs of capital against maintenance taking due account of the disrupting effect on production of emergency maintenance in a continuously operating mill. The present methods of rail mounting and fixing have been evolved in the past decade after a careful study of relative capital and maintenance costs. While the first cost may be greater than is commonly spent, it is often less than the cost price of the rail from the mills and the saving in maintenance over a relatively short period more than outweighs this expenditure in a busy mill.

A principal aim has been to develop a system which permits very speedy erection and service rail changing when this becomes necessary. The soft method of fixing can be used in all types of mill building carrying the heaviest ladle cranes, and in other heavy duty shops it affords a very high degree of protection against the maintenance engineers' problem of fretting corrosion, loosening and fatigue of fastenings, rail joint knock, fatigue of runway flanges, etc. Where the crane duty is low the hard method of fastening represents a very cheap and effective arrangement. ▲

Make Your Reservations Early!

AISE Annual Convention

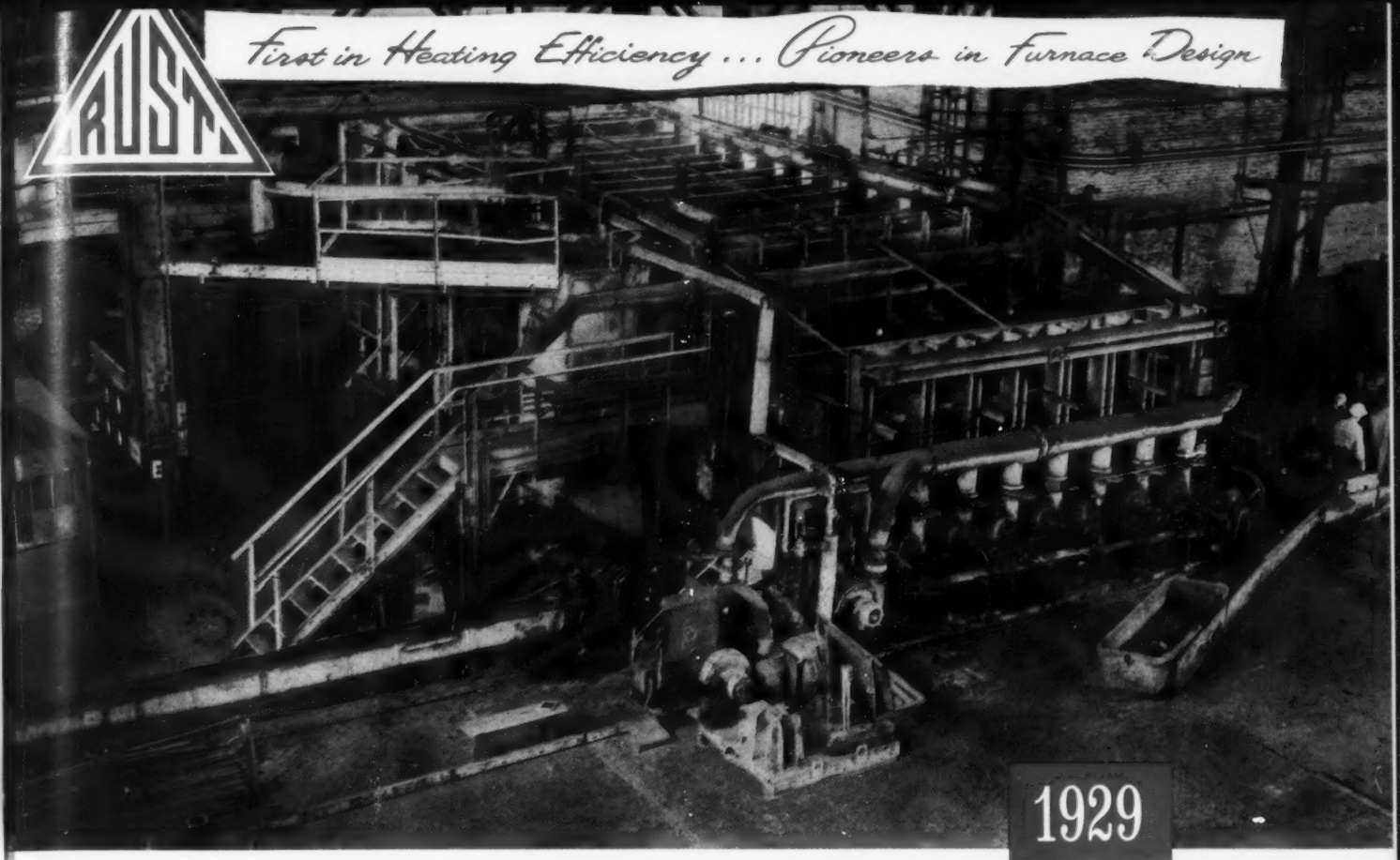
September 25, 26, 27, 28, 1961

Penn-Sheraton Hotel

Pittsburgh, Pa.

First in Heating Efficiency ... Pioneers in Furnace Design

RUST



FIRST Two-Zone, Top-Fired, Continuous Reheating Furnace was *built by RUST*, and still operates,

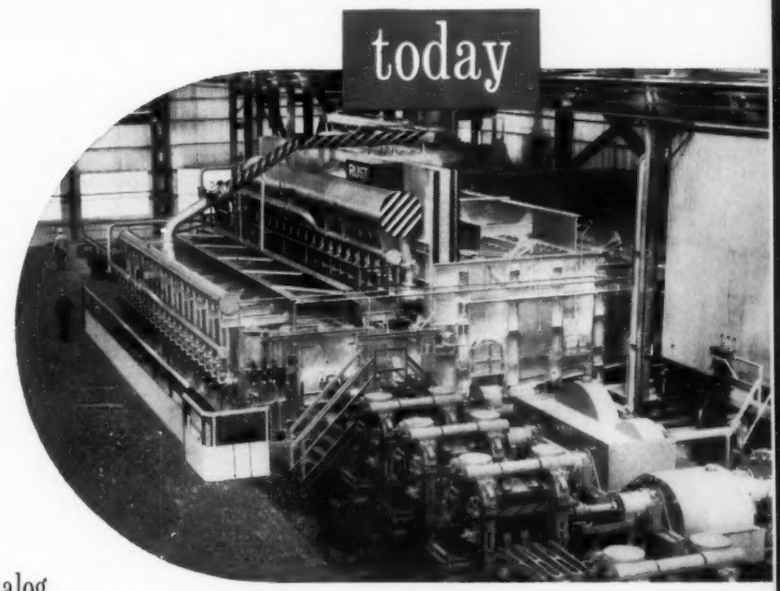
in a steel mill at Hamilton, Ontario

Since 1927, Rust has pioneered many 'firsts' in heating efficiency design including:

Two-Zone, Top-Fired Reheating Furnace	→ 1929
Three-Zone, Continuous Reheating Furnace	→ 1929
Four-Zone, Continuous Reheating Furnace	→ 1938
Five-Zone, Continuous Reheating Furnace	→ 1957

Over 600 successfully completed contracts assure the most advanced heating efficiency for meeting your needs in the melting, reheating or heat treating fields.

Consult us about your requirements. Ask for new catalog.



Modern, two-zone, continuous billet furnace at 10" rod mill, Sheffield Division, Armco Steel Corporation.

RUST FURNACE COMPANY

930 Fort Duquesne Boulevard, Pittsburgh 22, Pa.

F-28

First Industrial Process Control Digital Computer in the United Kingdom Programs Billet Shearing

A BRITISH steel manufacturer is rolling billets of high quality steel to lengths of up to 450 ft before cutting them to customers' requirements. Since the steel is largely to special order the billets must be cut to produce minimum wastage within the limits of the customers' specification and the length finally rolled. The problem is complicated by the layout of the mill which necessitates the use of cutting at two or three points.

The complete problem falls into four parts: first, the measurement of billet length; second, the calculation of optimum cutting points; third, the transmission and display of this information to operators; and finally, the recording of data for office purposes.

This problem has many aspects which indicate the great advantages that can be attained by the use of a digital computing system. The computation has to be fast enough not to hold up the billets on the track, a self-calibrating length measurement system is required and, since a number of billets can be on the track at the same time, considerable capacity for the storage of information is required.

The joint study of this situation by Samuel Fox & Co. Ltd. and E-A Automation Systems Ltd., (a member of the Elliott-Automation Group), showed that there was ample economic justification for a computer to optimize the cutting at this point and an order for such a system was therefore placed. The system has been designed to include the Panellit 609 information system which incorporates the Elliott 803 general-purpose computer.

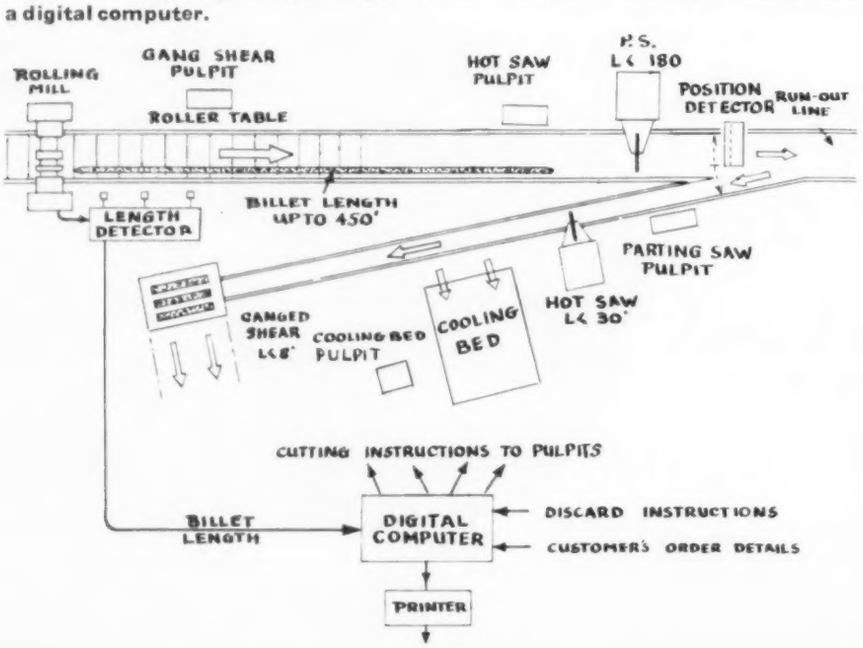
The measurement of length is obtained by a self-calibrating pulse-counting system which compensates for the wear on the mill rolls. The presence or absence of the billet being detected by lead sulphide detectors which have the correct spectral response to detect even the billets which have been delayed at an earlier stage of rolling and have therefore cooled to 750 to 930 F. This detecting system and its enclosure was specially designed by E-A Automation Systems Ltd. for this application.

The customers' order is setup on a panel controlled by the mill foreman. This method of input was chosen in order to maintain the personal responsibility of the foreman for the running of the mill. The order may specify for the final billet a fixed length, a limited continuous range or a range consisting of a series of steps. The computer must calculate the optimum cutting points to satisfy the customer's requirements within the mill operating conditions and also make allowance for the required test pieces as well as making statistical allowances for the variability of the stops at each saw and shear. This calculation takes less than a second and the information for the operators to use in setting their shears is therefore available within one sec of the billet leaving the final mill. Most of this information is, however, normally stored in the computer until it is called for by the operator.

Each operator has a display panel on which information relating to the billet that he is about to cut up is displayed following the operation of a demand button, and checks are provided in the computer to ensure that the billet operator is cutting corresponds with the one displayed on his panel. This is only one of a comprehensive series of checks in the computer program that ensure that any abnormalities in the operation of the system are rapidly detected and identified.

One of the advantages of the stored program of the 803 computer is that changes in mill or system operation can be incorporated with very little trouble at any stage of the design or after the system has been installed. The manual operations retained in this system can, of course, be replaced by automatic links when the system has been proved in operation should this appear to give further gains. ▲

Figure 1 — Billets up to 450-ft long are sheared to optimum lengths calculated by a digital computer.



SUPERTHERM*

Supertherm offers you outstanding service for applications that require dependable performance at temperatures from 1800 to 2300 F.

Developed by our Research Laboratory in Mahwah, New Jersey, this heat-resistant alloy has done an excellent job under extreme temperatures and severe heat cycling. In many cases it has extended service life two or three times over previous operations.

Supertherm has been cast as furnace rolls, radiant tubes, retorts, grids and other special parts. It is composed of 26% chromium, 35% nickel, and is strengthened and stabilized with cobalt and tungsten.

Our local sales engineers will be happy to answer questions that you may have regarding Supertherm or any high-temperature equipment problems. Or we will be glad to mail you technical data on this heat-resistant alloy, if you will kindly fill in the coupon and return it to us.

Electro-Alloys Division
3037 Taylor Street, Elyria, Ohio

Please send technical data
on SUPERTHERM

Name_____

Title_____

Company_____

Address_____

City_____

Zone____ State_____

**Supertherm is a patented alloy.*

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION · Elyria, Ohio

LIFT A COIL, SCRAP, OR LADLE

40/15 ton, 120 ft. span Yuba Bedford Crane in sheet mill coil storage area at U.S. Steel's Gary Sheet and Tin Mill, Gary, Indiana.

. . . JOBS FOR YUBA BEDFORD CRANES

Move steel coils into storage, out for shipment – position and dump scrap–lift and "spot" huge ladles of molten steel...these are the jobs Yuba Bedford Cranes are designed to perform effortlessly, dependably and continuously.

Bedford Cranes have done the difficult and the heavy work for steel makers for over half a century. During periods of high plant capacity, Bedford Cranes work ceaselessly shift after shift, with only routine maintenance. During periods of reduced capacity, these same cranes, with only slight modification, have been assigned to handle a variety of load ranges and services.

Whether you're modernizing or expanding it will pay you to check out savings that may be realized from the installation of Yuba Bedford Cranes. Full information on request.

Yuba designs and builds all types of cranes, including bridge, unloading and material handling, gantry and semi-gantry, floating and jib cranes. Also derricks, hoists, and launching towers for defense ordnance.

YUBA

specialists in steel mill cranes and custom cranes of all types

YUBA BEDFORD CORPORATION

YUBA CONSOLIDATED INDUSTRIES, INC.

Sales Offices in Chicago • Houston • Los Angeles • New York • Pittsburgh • San Francisco

Data Logging Supplies Mill Records

ROLLING mill at the Brackenridge works of Allegheny Ludlum Steel Corp. now writes its own production reports, turning out on an automatic typewriter and on punched tape the records formerly kept by men with pencils and clipboards.

The mill itself, a 4-stand, 56-in. tandem cold mill for rolling stainless and silicon electrical steel, has been in operation since 1952. For more than a year it has been equipped with a new system of advanced electronic controls, and it was recently converted to automatic logging of its own production data.

Conversion to automatic data logging not only increases the amount and accuracy of the information recorded, but also makes data more readily available for required production reports and for accounting purposes.

The more information which can be gathered and reviewed promptly, the more efficient and trouble-free the process of rolling steel to specified gages can be made. Allegheny Ludlum is recording data from the tandem mill that was physically impossible to collect by previous methods.

Information recorded during the steel-rolling process includes: gage of steel before and after rolling; customer order data; type of finish and melt number; month, day, shift, hour and minute of starting to roll each coil; identification of operator; width of steel; weight of coil before and after rolling; elapsed time for rolling; and elapsed time and cause of any delays. Such information is of great value in determining product mix, average rolling times, calculation of payroll data including incentives, product yield, production costs, major causes of downtime, calculation of mill capacity and similar factors.

The automatic controls and data logging system for the tandem mill were custom-designed and installed by members of Allegheny Ludlum's electromechanisms dept. using conventional components supplied by electronics equipment manufacturers.

Different departments of the company, such production, engineering, accounting, payroll and quality control, require somewhat different information relating to the production process. Allegheny Ludlum's new system can for the first time on any steel mill, it is believed, provide each of these groups simultaneously with just the information it needs, deleting for each group the data not required by it.

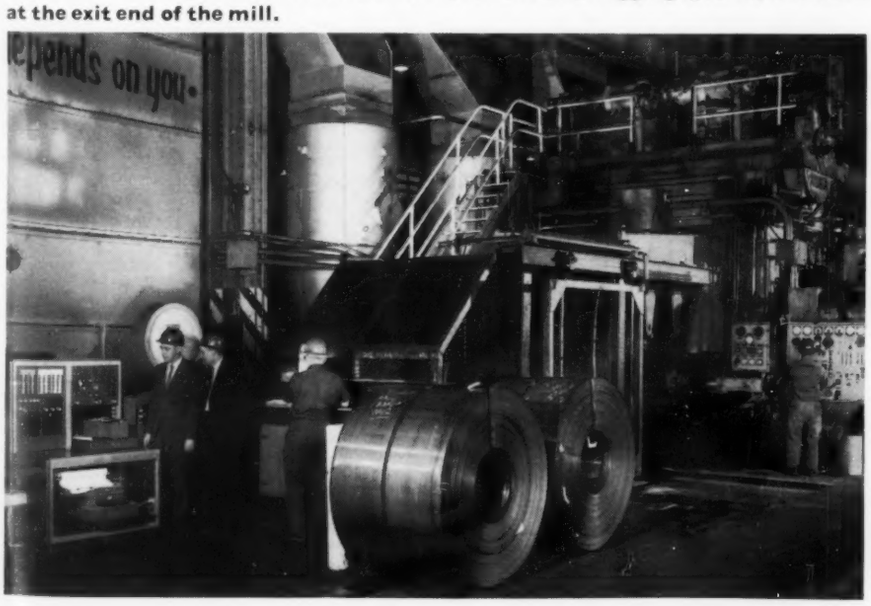
One major advantage gained by the automatic system is the elimination of any manual transfer of information from one set of forms to another. The "break out," or separation of data, is done by automatically transferring data from punched tape to automatic accounting cards. Once on the cards, any portion of the data can be reproduced automatically and processed mathematically as required. Automatic processing of data results in much greater speed in preparing required reports and in greater accuracy.

An important feature of the system is the provision whereby the production people themselves, by reference to the typewritten "readout" chart, can determine exactly "how they are doing" at any given time. The operator can tell at a glance whether material is being rolled to specified tolerances, and operators and supervisors can tell by quick reference to the neatly-typewritten and uniformly-tabulated chart how much production is obtained in any period and the reasons for any delays. In addition, routine production reports which previously required as much as two days to be processed and returned to the production dept. can now be prepared within a few hours.

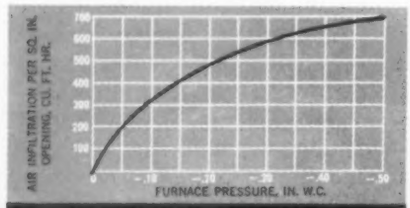
"Reason for delay," is one of the most useful items logged as a part of the production record. This system contains a panel with which the operator can, by pushing appropriate buttons, record any one of more than 60 circumstances requiring stoppage of the mill. The system is so designed that, once a halt in production is recorded, the mill cannot be restarted until the operator "punches in" the reason for delay. This control device insures a complete record of reasons for production stoppages, many of which are for routine maintenance, roll changes and similar causes.

In order to make maximum use of the increased volume of information gathered by the automatic data recording system, Allegheny Ludlum has recently installed an electronic computer at its offices in Pittsburgh. The computer will primarily process data relating to quality control and accounting. ▲

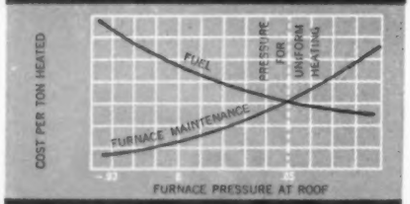
Figure 1 — The operator's control station, for the data logging system, is located at the exit end of the mill.



Why **furnace pressure control** should be considered the primary combustion control on heating and melting furnaces



The effect of negative furnace pressure on air infiltration.



The effect of furnace pressure on fuel cost and furnace maintenance.

When a negative pressure exists inside a furnace, appreciable quantities of air pass through the walls and openings of the furnace structure. Actual tests have shown that even in an apparently tight furnace the amount of air infiltration can be as high as 40% of the total air required for combustion.

Thus, uncontrolled air infiltration can completely negate the function of accurate fuel-air ratio control. It leads to fuel waste, uneven and irregular heating, excessive cooling of the furnace, and flame impingement on the contents and walls.

On the other hand, uncontrolled high furnace pressure causes undue heat loss through the furnace walls and openings, the possibility of dangerous blow-outs when doors are opened, and high refractory maintenance cost.

In a properly designed furnace, the furnace pressure that is best for effective heating or melting is also the pressure that provides an optimum relationship between fuel costs and maintenance costs. Precise control of furnace pressure at this one best value is a first necessity for efficient operation.

...and why **GPE Controls** can bring more experience than any other control builder to furnace pressure control applications

GPE Controls Hydraulic Pressure Controller. Thousands of these units are now providing precise pressure control on heating and melting furnaces of all kinds.

GPE Controls Electronic Furnace Pressure Transmitter. Electrohydraulic control system combines advantages of electric transmission and hydraulic operation.

Two generations of heating and melting furnace operators and builders have relied on GPE Controls for furnace pressure control. GPE Controls developed the concepts that made furnace pressure control practical.

The pressure range of a GPE Controls furnace pressure controller is -0.05 to $+0.15$" w.c. Accuracy of $\pm 1\%$ is equivalent to holding the "zero pressure" level of the furnace within 3" vertically—the degree of accuracy that GPE Controls equipment is designed to provide.

GPE Controls now adds the advantages of electronic transmission to the proved hydraulic control system. The furnace pressure transmitter shown at the left converts the furnace pressure signal to a high-level d.c. voltage signal. Used with GPE Controls electronic controller and electrohydraulic valve actuator, it eliminates long pneumatic signal lines and hydraulic lines. The same furnace pressure signal can operate not only the control but also recorders and indicators. Installation and maintenance are both greatly simplified.

Always be sure to specify GPE Controls furnace pressure control—the primary combustion control.

Write for descriptive literature

GPE Controls, Inc.

240 East Ontario Street • Chicago 11, Illinois

GPE Controls

A Subsidiary of GENERAL PRECISION, Inc.

Tube Mill Welder Is Vapor Cooled

THE development of a new vapor-cooled toroidal transformer which both increases amp-to-weld and decreases power input requirements, has been announced by The Yoder Co., manufacturers of ferrous and nonferrous pipe and tube mills.

Through the use of the new "Type-V" welder, pipe production is increased as much as 60 per cent over conventional equipment under identical power input and operating conditions, or identical speeds at greatly reduced power requirements. During initial tests 18-gage tube was produced at the rate of 120 fpm without taxing the equipment.

Key features of the Type-V welder are a cooling system using a nontoxic fluorocarbon instead of recirculated water or oil, and the compact design. These make possible the elimination of the secondary conductor system, thereby greatly reducing the secondary impedence and permitting the current to be transmitted directly from the transformer to the electrode.

As a result of these technological advances, the rotor unit is approximately one third smaller than rotors on conventional cross-type transformers and the transformer itself has been reduced in size by 75 per cent.

This new type welder provides several major user benefits:

1. Twelve-gage tube, formerly

Figure 1 — Freon, which is used as a cooling medium, is sealed in the case enclosing the welder primary and core.

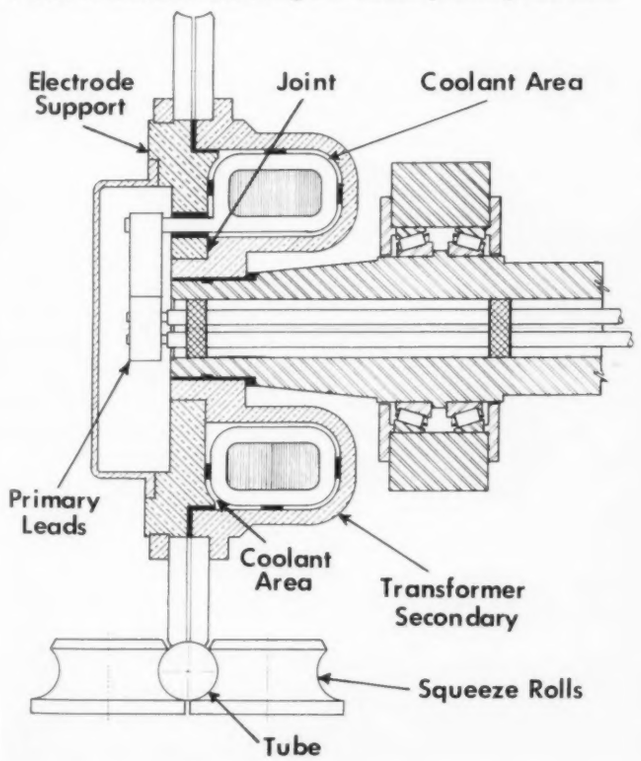
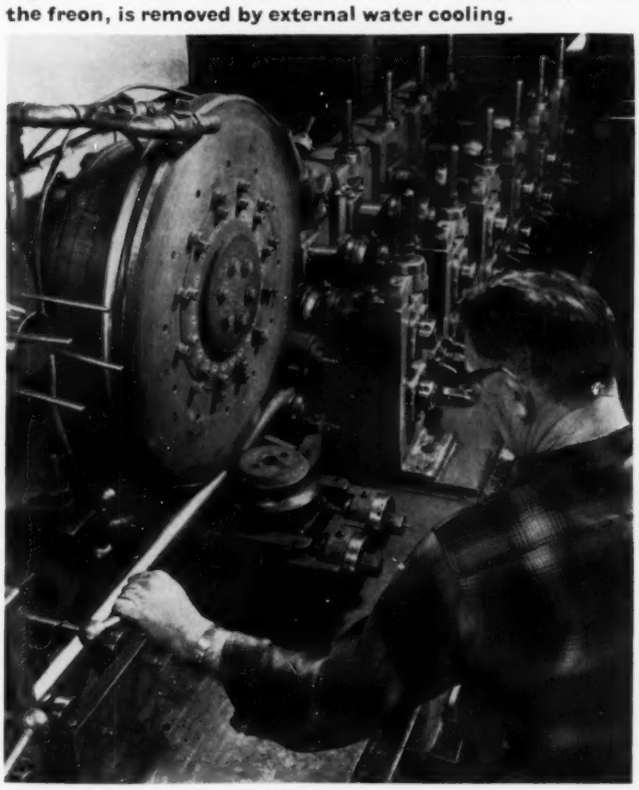


Figure 2 — Heat transferred to the secondary case, from the freon, is removed by external water cooling.



produced at the rate of 50 fpm on conventional welders, is being produced at 80 fpm on the Type-V welder, a 60.0 per cent increase; and 14-gage which was produced at 85 fpm, and is now produced at 106 fpm, a 26 per cent increase.

2. Hotspots throughout the transformer have been eliminated and the unit can now be pushed to capacity within the limits of the insulation. In a cooling system test on a given load the cross-type transformer had an average temperature of 125 F with 190 F hotspots. On the same unit, using vapor as a coolant, the average temperature was 120 F with 130 F the hottest spot.

Because of simplified design and construction, maintenance and downtime have been reduced.

1. On older welders, electrodes have to be dressed about once a day. Electrodes on the Type-V welder require dressing only every two to three days.

2. Cross-type rotor assemblies have several joints in the secondary circuit. Yoder engineers have designed this new unit so that it requires only two sections, and thus has only one joint.

3. When conventional transformers are cooled by recirculating water through the unit, dangers such as corrosion, short-circuiting due to faults and stresses exist, which can eventually damage water tubing and joints. Using a dielectric fluorocarbon, stresses have been completely eliminated and there is no way for the unit to short out.

For any given job power requirements are reduced.

1. Less input power is required, consequently for new installations lower over-all initial investment is required. Smaller generator sets, motors and starters are needed.

2. Advances in insulation have also been incorporated into this new transformer to make it more compact.

The unit is completely self-contained. There are no hoses, no rotating seals, and no pumps; there is nothing to connect except the incoming power supply.

The immersion system has been employed to cool the Type-V welder. As heat builds up within the unit the liquid vaporizes, hits the transformer case, condenses, and then returns to the liquid state.

Producing automobile and truck tailpipe, one manufacturer is welding cold-rolled and aluminized steel on the new equipment. They are welding 2-in. diameter tube of 0.075-thick steel at 106 fpm. They are producing 3700 pieces of 101½-in. sections or 6000 pieces of 69½-in. aluminized steel sections in an 8-hr shift. Two operators, one directing the continuous coil feed and one welder operator, are employed on the line. ▲

Magnet Removes Tramp Steel From Roadway

A GIANT magnet has proved an effective tool in the periodic cleaning of the ten miles of plant highways and storage yards at The Timken Roller Bearing Co.'s Gambrinus plant.

These areas, used extensively by employees' automobiles and by pneumatic-tired straddle carriers hauling steel bars and tubes between plants, require careful maintenance.

Figure 1 — The entire unit is easily handled by a standard fork truck.

A magnet-equipped fork lift truck is used to pick up metal debris. The components of this equipment are a circular magnet and a 15-kw gasoline-driven generator.

The magnet is hooked onto the frame of the generator and the generator has been fitted with channels to facilitate lifting by the forks on the lift truck. The operator controls the generator and magnet from inside the cab. He can energize or de-energize the magnet by a single lever control. Any size magnet, from 4000 to 9000 lb, can be used with the generator.

The flexibility of this equipment helps immeasurably in the task of road maintenance. Both the magnet and generator can be mounted on the fork lift truck in less than five min. It also takes only five min to remove them, enabling the truck to be returned to its regular job of moving steel in a minimum period of time. ▲

. . . for Steel Mill Cranes

Over 150 P-G Standard Resistor units are used to control this 350-ton Ladle Crane. These rugged nonbreakable units help keep this large crane in continuous operation. Built of steel and mica, there is nothing to break. P-G Resistors have afforded low cost protection to many steel mill applications for over 25 years. You, too, can obtain this same "Trouble-Free Service" if you specify P-G the ORIGINAL Steel Grid Resistor for your next application. Write for Bulletin No. 500.

The Nonbreakable Steel Grid Resistor

P-G

ESTABLISHED 1892

THE **POST-GLOVER** ELECTRIC COMPANY

OFFICE and FACTORY—Kenton Lands Road, Erlanger, Kentucky

MAILING ADDRESS—Box 709, Covington, Kentucky

Powered Steel-Strapping Equipment Increases Production

THE proper application of powered steel-strapping equipment has made it possible to triple the slit coil production of United Flat Rolled Products. In the past slit coils of steel were strapped with hand tools as they were taken from the rewinder. This was a time-consuming process resulting in as much as 45 min per hr of downtime as the slitting equipment waited for the coils to be strapped and removed.

Production bottlenecks occurred frequently and efficient use of the equipment was not possible. It was necessary to conveyorize production flow and increase the strapping speed to match the speed of the slitters.

To accomplish this, United installed necessary conveyor lines, a special curved conveyor section mounted on a roller turntable, one Acme Steel Co. F4A5 steel strapping machine with 48-in. automatic indexing table and E33 Steel strap dispenser, and an Acme model B1P6 pneumatic stretcher plus C8G sealer and unit-load band dispenser, and one E45 overhead tool mount.

In operation, inclined conveyors carry coils from each slitting machine to the curved, roller-mounted conveyor section. This section can be rotated through an arc of about 90 degrees so that it can je either conveyor, in effect, serving as both upper arms of the "Y" joint in the conveyor system, and move coils to the strapping area at the base of the "Y."

Actual strapping consists of three operations:

In Figure 1, a coil has been moved along the roller conveyor line, over the curved conveyor, and onto the indexing table in front of the strapping machine. The strapping operator has centered the coil and raised three tapered rollers to elevate it above the table top. Strap is fed from below through the center of the coil, and the operator inserts it back into the strapping machine. Pressing a cycle button automatically tensions, seals and cuts the strap.

Figure 1 — The coil is raised, rotated and strapped using a rotary indexing table and an alternate strapping machine.

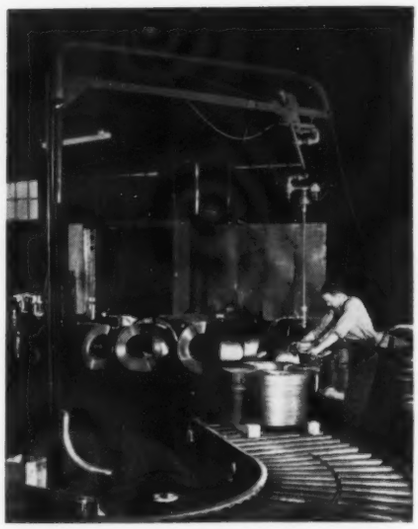


Figure 2 — The individually strapped coils are stacked and strapped together on 4 x 4-in. skids.

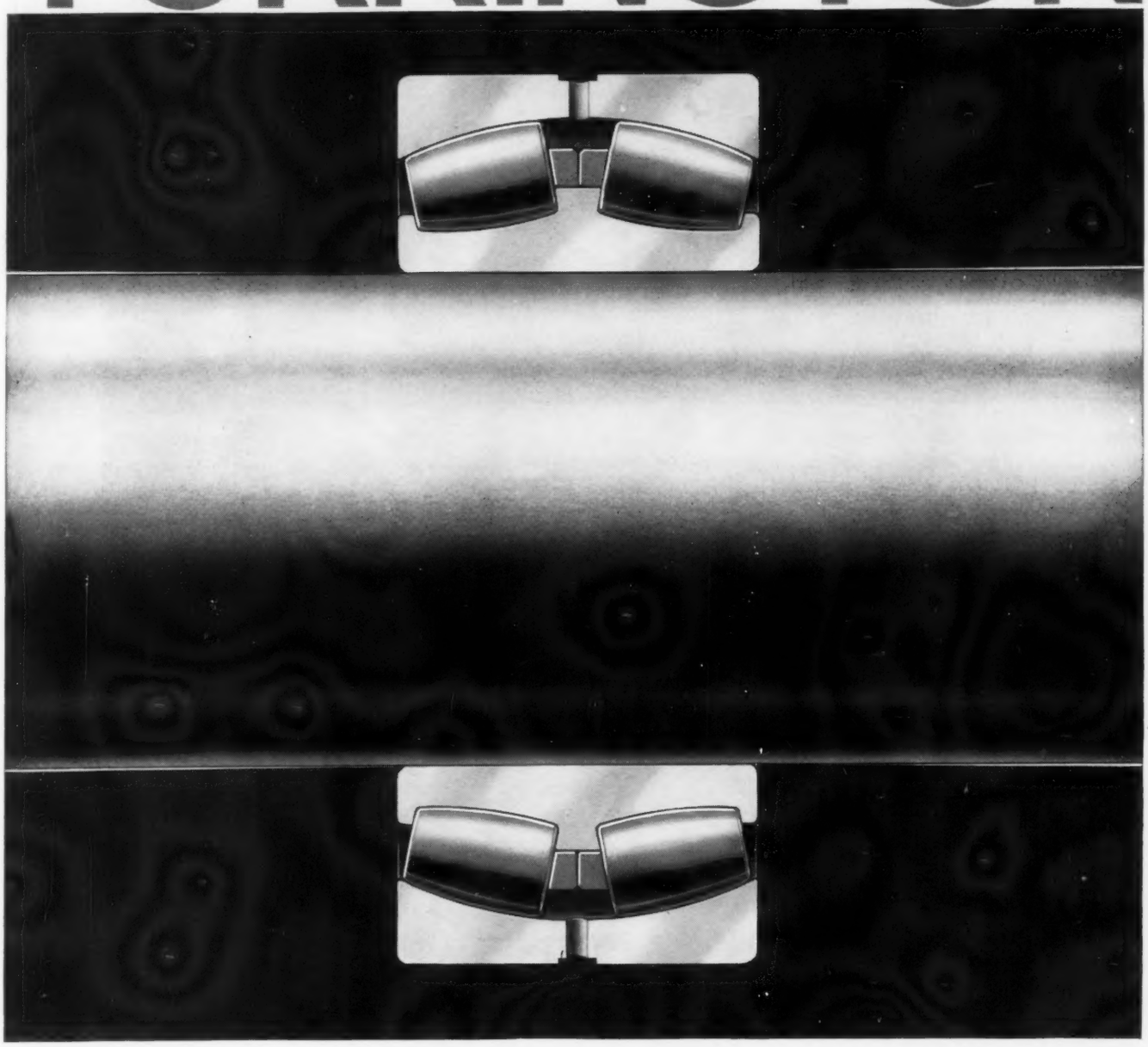
By pressing another button on the control panel, the operator rotates the coil to position for another strap. Either three or four straps, properly spaced around the circumference, are applied depending on size of the coil. Following this, the operator lowers the tapered rollers, thus lowering the fully strapped coil, then moves the coil down the conveyor to just beneath the overhead hoist.

The operator stacks as many as 12 coils, depending on the height of each coil, on to 4 x 4-in. runners or skids. He then moves the unitized stack to the final strapping station.

In Figure 2 is shown the model B1P6 pneumatic stretcher and the C8 Sealer are suspended from an E45 tool mount that moves in trolley track on an overhead jib boom. The unit-load band dispenser is at the base of the boom, and it feeds strap through three curved sections of pipe to the tool position. The operator applies four ¾ x 0.035-in. unit-load bands to each stack of coils, tensions each with the stretcher, then seals and cuts the strap with the sealer.

One man not only keeps up with the coil output of the two slitters but actually works ahead of the high-speed machines. ▲

TORRINGTON



SPHERICAL DESIGN FOR SUPERIOR PERFORMANCE

Full bearing capacity with 3° total misalignment...is an outstanding feature of Torrington Spherical Roller Bearings.

Spherical design compensates *within the bearing* for both static and dynamic misalignment...offers design engineers wide latitude plus considerable savings in production costs.

Result...superior performance, higher radial and thrust-load capacity, longer bearing life.

Torrington Spherical Roller Bearings stand up when other bearings give up. They're backed by Torrington experience in making every basic type of anti-friction bearing. Buy the best...specify Torrington.

TORRINGTON SPHERICAL ROLLER BEARINGS
offer these features:

- ☐ integral guide flange for roller stability
- ☐ asymmetrical rollers seek flange for positive guidance
- ☐ electronically matched rollers
- ☐ size-stabilized races
- ☐ fully machined land-riding bronze cages
- ☐ controlled internal clearances
- ☐ even load distribution
- ☐ inherent self-alignment
- ☐ long service life

progress through precision

THE TORRINGTON COMPANY

TORRINGTON BEARINGS

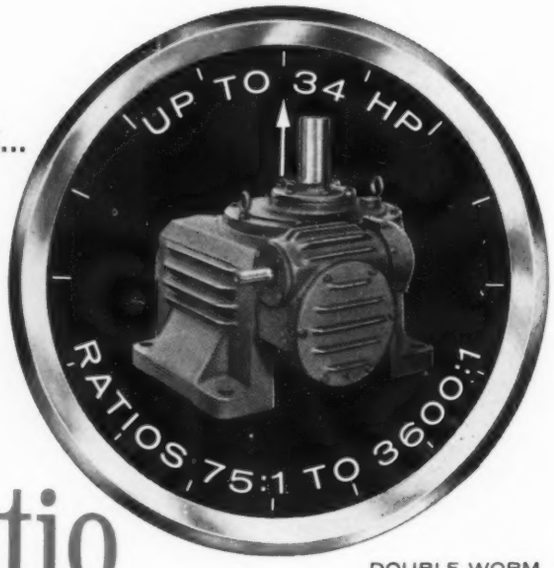
South Bend 21, Indiana • Torrington, Connecticut

SINGLE WORM

HELICAL-WORM

LINK-BELT fan-cooled worm gear speed reducers...

the compact way to achieve high-hp, high-ratio reduction



DOUBLE-WORM

3 BASIC DESIGNS . . . WITH MANY VARIATIONS! Link-Belt worm gear speed reducers are the space-saving, economical answer for every right-angle speed reduction job. You have your choice of industry's *most complete* range of types, ratios, and sizes . . . in single and double reductions . . . with many combinations of input and output shaft arrangements.

Fan-cooling is the key to the exceptional compactness of this high horsepower, high ratio line. An aluminum radial fan directs a steady flow of cooling air over the finned sides of the housing. This assures maximum heat dissipation . . . permits high horsepower, high ratio reductions in minimum space . . . pays off in lower initial cost for each center distance.

Other features include: rugged, carefully machined housings; automatic splash lubrication; durable centrifugally cast bronze-alloy gears; hardened, ground and polished nickel-steel worms; high-capacity roller bearings.

ASK OUR FIELD ENGINEERS to help you with your application problems. They will specify the speed reducer that *exactly* matches your needs. With industry's most *complete* range of types and sizes to work with, their recommendations are unrestricted, unbiased. Contact your nearest Link-Belt office or authorized stock-carrying distributor. Ask for Book 2824.

15.677

LINK-BELT

SPEED REDUCERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13) South Africa, Springs; Switzerland, Geneva. Representatives Throughout the World.

Structural Innovations Feature New Great Lakes Steel Mill Buildings

THE new 80-in. hot strip mill of Great Lakes Steel Corp. will become operational this year as the fastest and most automated rolling mill in the world.

Structurally, designers and contractors are making use of the latest methods in construction processes with emphasis on in-the-shop welding and high tensile bolts in preference to conventional riveting. The mill buildings have more welded girders than projects of comparable size.

Under a roof expanse of 20 acres, the mill stretches away in six parallel aisles spearheaded by the main hot strip mill extending 2160 ft. The bays differ from the customary 20 to 25-ft width, being 48 ft in the mill building and 64 ft in the furnace area. Truss spans are 120 ft in the slab preparation yard and coil storage buildings, 106 ft in the mill aisle and maintenance and shop areas.

One of the major assignments of Whitehead & Kales as prime contractor was fabrication of 17,200 ft of runway girders capable of supporting cranes of varying capacities up to 125 tons. The larger runway girders are 88-in. deep for the 48-ft spans and 102-in. deep for the 64-ft spans. One 96-ft span required a girder of 126 in. Crane sizes vary from a 15-ton crane to the 125-ton crane, used in four of the aisles, the latter having a maximum wheel load of 145,000 lb (without impact) and a speed of 300 fpm.

In fabricating these girders, Whitehead & Kales utilized a submerged arc Lincoln welder, first of its kind employed in a structural fabricating plant, a large unit capable of making one continuous $\frac{5}{8}$-in. fillet weld deposit in a single pass.

The only hand welding in the in-shop girder fabrication phase was the affixing of web stiffeners.

Knee braces, long a standard in crane support construction, were eliminated in favor of vertical X bracing, designed to stiffen the structure and resist the longitudinal forces inherent in crane movement. One vertical X brace was mounted directly on centerline near the center of each expansion length of the building. This location controls the direction of expansion and avoids stressing of the bracing by the expansion forces themselves.

Another innovation attacked the problem of rivet shear failure. Traditionally crane girder connections to columns have been made at the web of the girder by means of a single, full-depth rigid diaphram. The drawback to this method was a tendency toward shear failures of fasteners.

A secondary unwanted effect of the old diaphram design was partial restraint of the normal deflection of deep simple span girders.

A new column connection was devised using two smaller, flexible diaphrams at each column, one from each girder. Made of $\frac{3}{8}$-in. plate and connected directly to the top flange of the girder where the forces are applied, the flexibility of the new diaphrams allows for any deflection movements of the crane girders.

Welding was used exclusively for all jack trusses and building columns. The jack trusses run alongside the crane girders and are designed to carry the intermediate columns used to support the roof trusses, and to provide a stiffening companion structure for the long crane girders. Not a single hole was punched or drilled in the main shaft of the main building columns.

The prime contractor also introduced high tensile bolts in place of the traditional rivets for roof trusses. It was felt that the high tensile bolt method, long used successfully in the field, could be used economically in the shop although the cost of bolt, nut and washer was almost three times that of a rivet. ▲

Figure 1 — Erection was simplified by the large amount of in-shop fabrication.

Square and Rectangular Structural Tubing Produced by National Tube

THE National Tube Div. of U. S. Steel has developed a new line of hot rolled carbon steel hollow structural tubing: a wide size range of square and rectangular hot rolled hollow structural tubing, produced on conventional pipe mills to structural steel specifications.

The use of the tube for fixed load-bearing structural purposes has been a long-established practice in many European nations, ever since it was employed by pioneering bridge builders over 80 years ago.

In countries such as England, Germany, Italy and France, pipe and tubing forms the framework for tall modular buildings, airplane hangars, mammoth sports arenas, industrial warehouses, factories and buildings and transmission towers.

The development of new welding techniques has made it possible to connect the total cross section on one tube to another. The result is a more effective transfer of forces within the structure which can yield a weight saving as high as 60 per cent compared to riveted rolled structurals.

Refinements in welding techniques have generally simplified jointing methods for structural tubing in three ways: (1) being a continuous connection, the welded joint provides excellent resistance to compression and torsion; (2) sealing of the tubing can assure long resistance to interior corrosion; and (3) a sealed tube builds up internal pressure, when subjected to fire, resulting in increased resistance to deflection.

Specifications were developed for minimum wall thickness and maximum strength, with proper ratios of OD to ID.

The last major obstacle was the development of an economical process for rolling structural tubing to structural, rather than pressure, specifications. Previous methods were specialty operations involving turks-head drawing of seamless tube or by welding fabricated sections.

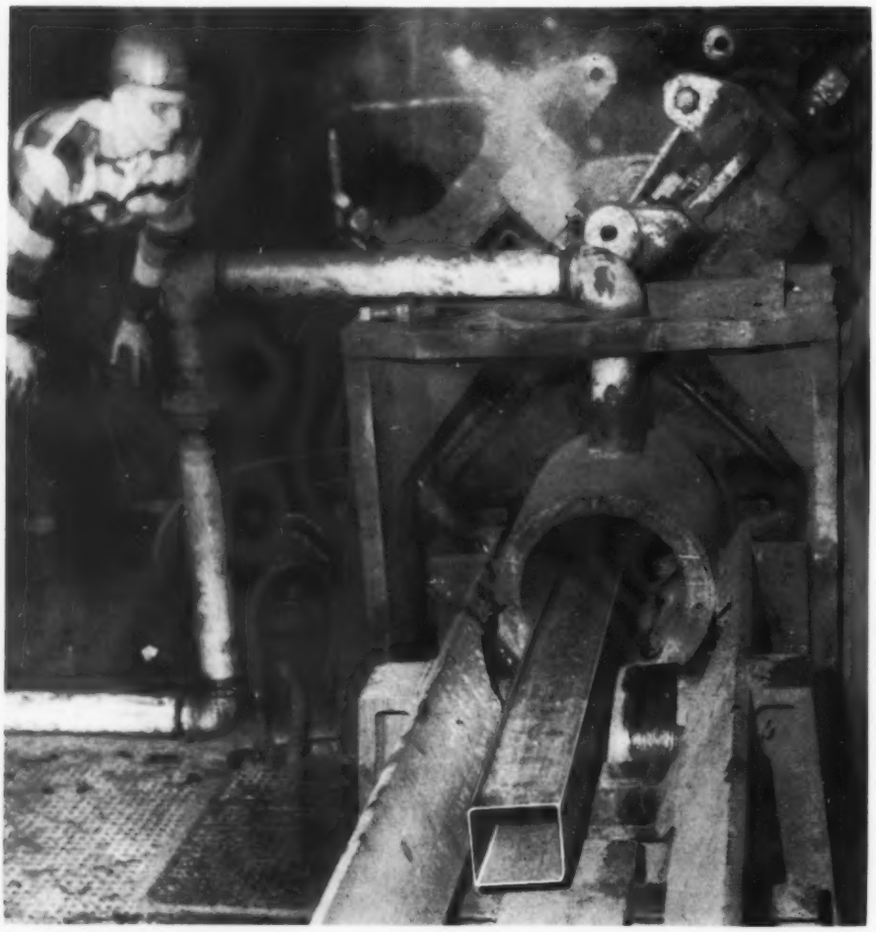
Roll pass designs were developed and an economical, continuous operation was devised which eliminated several costly steps in processing, and allowed the utilization of standard tube mill equipment.

The new product will be initially hot rolled from ASTM A7 (33,000-psi yield strength) and ASTM A36 (36,000-psi) carbon steel. High-strength steels and other steel grades can also be rolled.

Square tubing is available in the range from one x one in. through eight x eight in. Rectangles are available from three x two in. through six x four in. and perimeters through 20 in. The tubing is stocked in lengths, 36 to 42-ft long, and is also available in cut lengths or multiples.

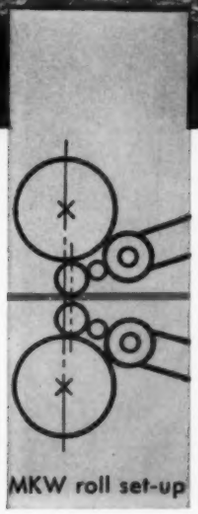
The product can be subjected to most of the usual fabricating operations. Its ductility is good, and it bends, flattens, cuts, punches, flares and flanges easily. It can be welded by the commonly employed techniques and practices. ▲

Figure 1 – Square tubing is formed and sized on modified conventional tube mill equipment.



SCHLOEMANN

MKW mill rolling alloy steel strip 50 in. wide in a Swedish steel plant



MKW roll set-up

MKW in Sweden

For the past three years an MKW mill in Sweden has rolled wide alloy steel strip. MKW rolling mills in Europe, North and South America today produce many thousands of tons of high-grade steel and non-ferrous strip every year. MKW mill stand designs are patent-protected. Constructed on simple lines they are thoroughly dependable. As small-diameter work rolls are used at high speed, large pass reductions and close tolerances are obtained.

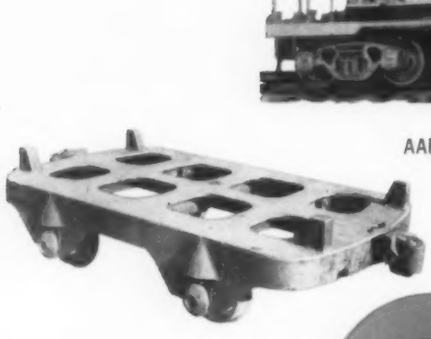
MKW rolling mills can be equipped with four types of roll set-up (two-high, four-high, MKW and double MKW), and as a result their range of application is correspondingly expanded.

FELLER ENGINEERING COMPANY 1161 Empire Building, Pittsburgh 22, Pa.

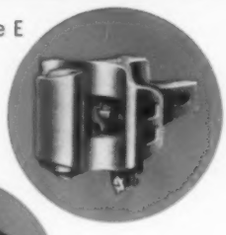
HOT AND COLD ROLLING MILLS • COUNTERBLOW HAMMERS • HYDRAULIC PRESSES

CAR PROTECTION !

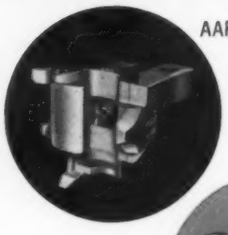
There's a National combination of Coupler and High Capacity Rubber Draft Gear to fit your car and its protection needs. Increase car availability, reduce maintenance time and cost.

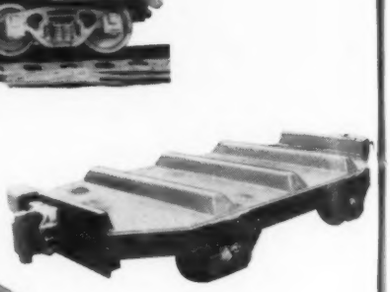


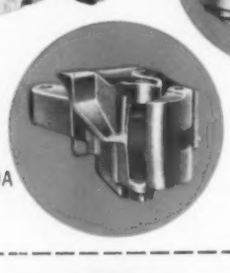
AAR Type E



AAR Type F

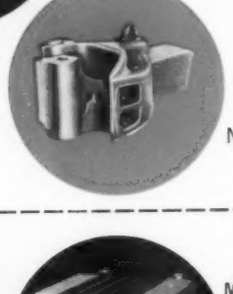






Sharon-10A

NATIONAL COUPLERS

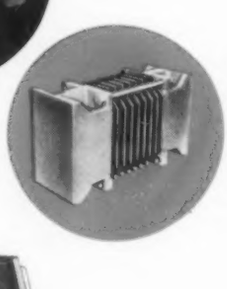


National AP

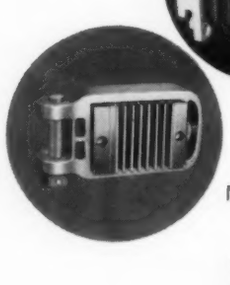
MF-400

NATIONAL RUBBER DRAFT GEARS

MS-485-6A

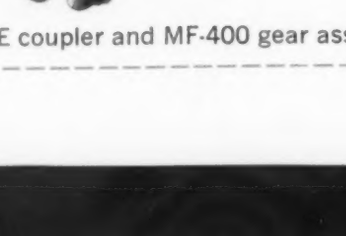


MF-491-A



MI-225-6 and Yoke

Transportation Products Division



Type E coupler and MF-400 gear assembly

NATIONAL CASTINGS COMPANY

Cleveland 6, Ohio

A-2361A

Tar Distillation Plant Started by U. S. Steel

A NEW tar distillation plant, replacing existing facilities, that will enable United States Steel Corp. to increase production of high-quality coal chemicals at the Clairton works is now in operation.

This new tar distillation plant is capable of producing a stream of chemicals derived from coal: many of the pharmaceuticals, synthetic fibers, plastics, building materials and wood preservatives required in civilian and military operations.

The tar processed in the new plant comes from the gas that is driven off when coal is heated in the coke ovens. Tar is a combination of many chemical compounds including naphthalene, creosote, tar acids, tar bases and pitch, each with a different boiling range at which these compounds can be recovered from the tar. This plant was especially designed to separate these components on this basis.

The plant consists of two identical distillation units each containing multiple fractionating columns, together with instrumentation for precise control during each distillation phase. The multiple column design assures a sharp separation of the components and production of chemical products to strict specifications. Further flexibility is provided to vary operating conditions to meet anticipated future commercial requirements for improved product quality and additional tar components.

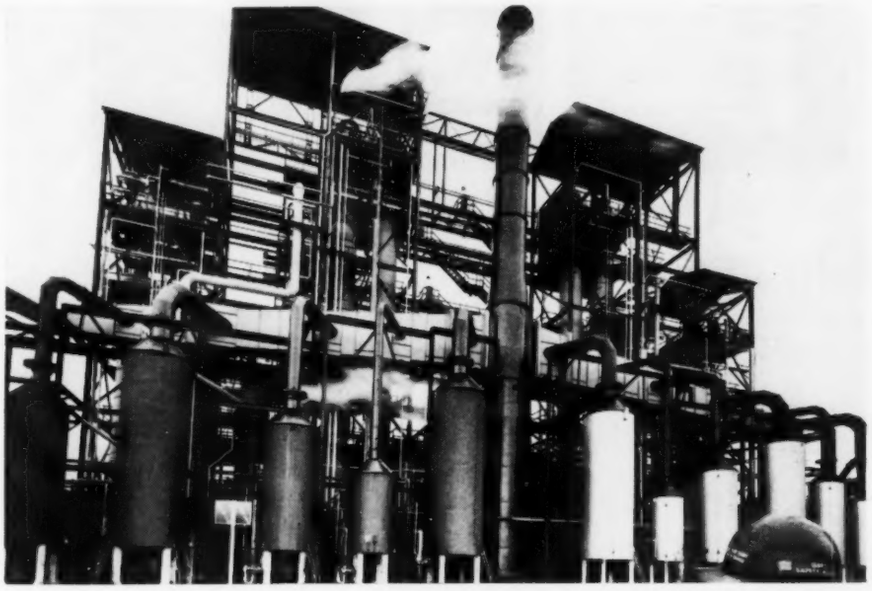


Figure 1 — Multiple fractionating columns permit close control of distillation phases.

The new tar distillation plant enables the Clarion works to continue to meet the changing demand for coal chemicals and to meet customer needs for high-purity coal chemicals. ▲

Corporacion Venezolana de Guayana to Receive Management Advice from Koppers

A LONG-term management advisory contract with Corporacion Venezolana de Guayana has been entered into by Koppers Co., Inc., involving the new 825,000-ton per year integrated Orinoco steel plant at Matanza, Venezuela.

The management advisory agreement provides for starting up the various units of the plant in a rapid and efficient manner. In addition to startup activities, Koppers personnel will, on a continuing basis, advise and work closely with the Corporacion on all matters concerning the completion of construction and continued operation of the firm, including executive management, long-range planning, financial and control functions, marketing of products, plant maintenance and technical assistance in all phases of plant operation. Koppers responsibilities also embrace the instruction and training of Venezuelan personnel at all levels of management so that, as rapidly as possible, Venezuelan nationals may assume complete responsibility.

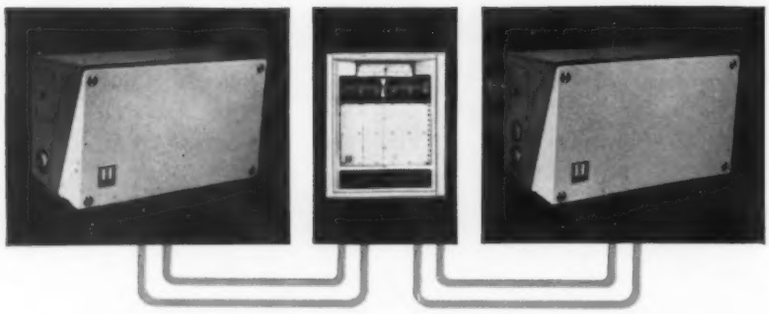
In the execution of this contract a general management mission headquartered in Caracas, with a number of technical personnel of the mission stationed at the Orinoco plant will be furnished.

Orinoco steel plant—The steel plant is located on the Orinoco river at Matanza in the State of Bolivar, about 300 miles southeast of the capital of Caracas. The plant will use Venezuelan high-grade iron ores.

The plant has been under construction since March, 1957, by the Italian contractor Innocenti S. G. of Milan, Italy. Initial portions were recently put into operation. The seamless tube mill and the wire drawing plant are expected to be in operation utilizing imported semi-finished steel during the next few months.

When the first stage of construction is completed in 1963, the Orinoco plant will have an annual ingot capacity of 825,000 tons. Finished products will include reinforcing bars, structural sections, rails, wire, cast iron pipe and a capacity of from 330,000 to 550,000 tons annually of seamless tube.

Nine electric smelting furnaces are used to reduce iron ore to pig iron. These furnaces, the largest of their type in the world, have a combined rated load of 297,000 kva, and each will be able to produce from 220 to 242 tons of pig iron per day. The pig iron will be refined to steel in four 275-ton open hearth furnaces. ▲



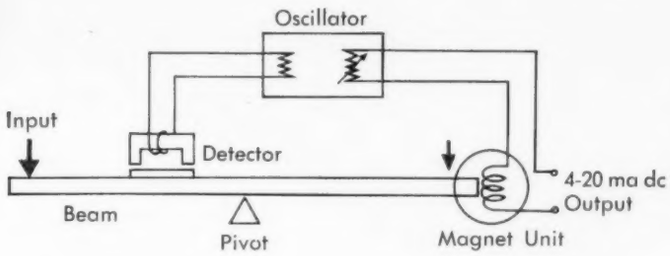
***ElectriK Tel-O-Set*—the true 2-wire system**

Care and feedback of delicate inputs

Delicate inputs thrive on the tender care of *ElectriK Tel-O-Set's force-balance feedback system*. This system, used as the basic circuit in *Tel-O-Set* transmitters, receivers, controllers, and other instruments, has proved itself in thousands of installations in the last five years. The force-balance feedback circuit increases the accuracy and dynamic response of the system by decreasing hysteresis effects and sensitivity to changes in ambient conditions.

Observe: (1) input force (from bellows, Bourdon tube, or displacement linkage) deflects pivoted beam; (2) air-gap in ferrite detector increases, (3) producing a change in inductance in oscillator circuit; (4) a portion of output current is fed back into magnet unit, producing a force on beam which is equal and opposite to input force; feedback balances beam. Full scale motion is only one-thousandth of an inch.

The advanced control engineering seen in force-balance feedback is carried through the entire *ElectriK Tel-O-Set* System. Specifically, there's no external power required at any field-mounted *Tel-O-Set* instrument. Line power connection is made only at the receiver. Two-wire d-c transmission eliminates shielding problems. The 4-20 milliamp signal range of the system gives a live zero and permits the use of the most reliable transistors available. The d-c signals



can be fed into data handling systems and millivolt-actuated instruments . . . can be easily transduced to a standard 3-15 psi pneumatic signal to operate existing pneumatic systems.

Take a new look at your control applications with the *ElectriK Tel-O-Set* System in mind! Get complete technical data from your local Honeywell field engineer. Call him today . . . he's as near as your phone. MINNEAPOLIS-HONEYWELL, 21 Penn Street, Fall River, Massachusetts.

Honeywell

First in Control

SINCE 1885

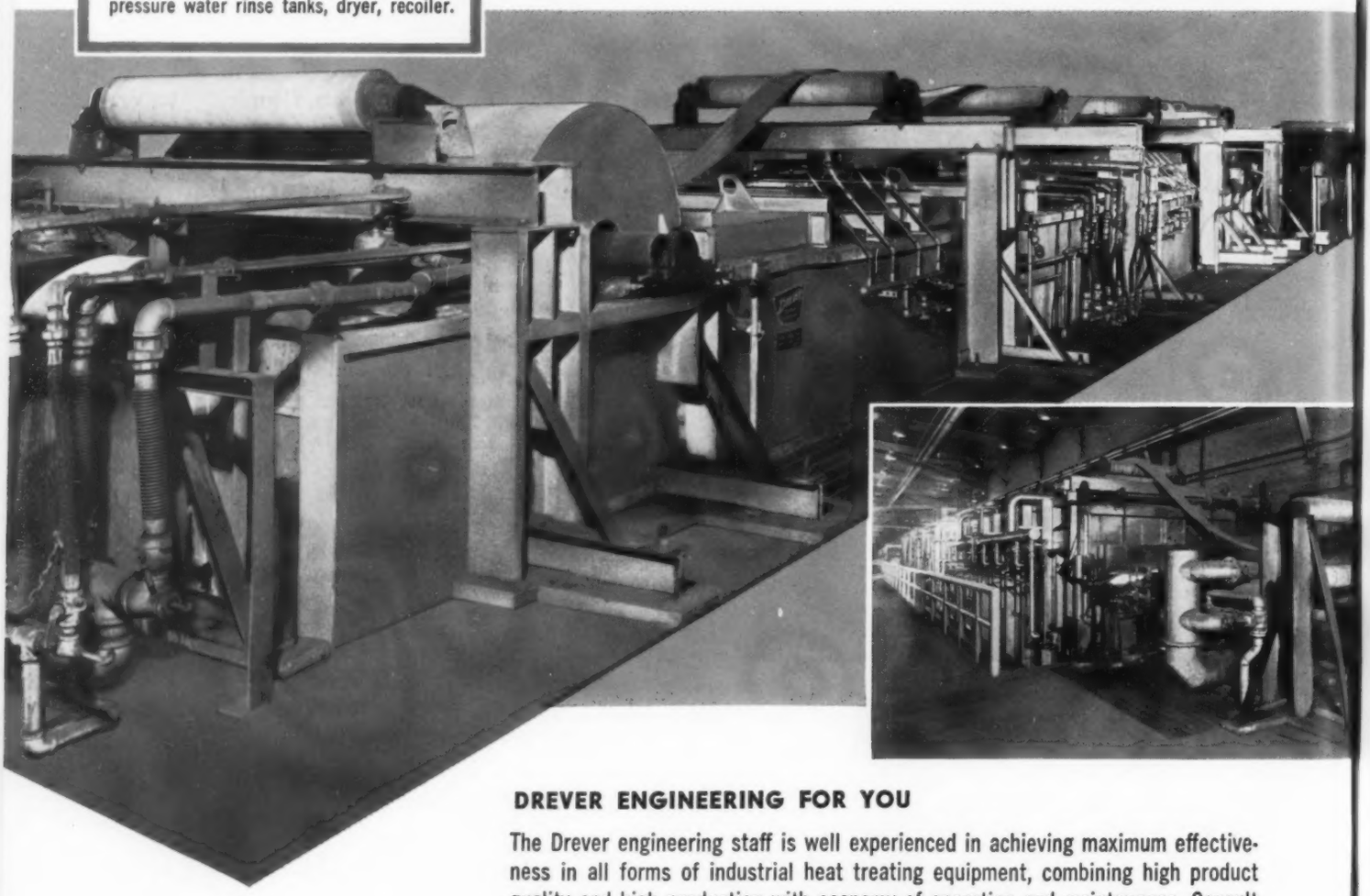
PUTTING A FINE FINISH ON STAINLESS STRIP—

DREVER CONTINUOUS DESCALING SALT BATH

Users of stainless strip are demanding high finishes that reduce their own production problems. To achieve this standard of finish on the heavier gauges of series 300 strip, a Drever Continuous Descaling Salt Bath provides high quality, fast descaling. The strip is immersed in a molten salt bath at controlled temperatures up to 950°F, no atmosphere is required, and speeds up to 150 FPM are attained. Gauges from .018″ to .095″ in widths up to 52″ are handled from coils weighing as much as 10 tons.

Drever designs and builds batch and continuous salt baths for stainless strip, plate, bar, wire or tubing. Or, complete lines providing for continuous annealing and descaling can be engineered to the producers requirements.

This Drever Continuous Descaling Salt Bath receives cold rolled strip at bath temperature from the annealing furnace shown in the smaller picture. Descaling unit consists of salt bath, water quench, acid dip, high pressure water rinse tanks, dryer, recoiler.



DREVER ENGINEERING FOR YOU

The Drever engineering staff is well experienced in achieving maximum effectiveness in all forms of industrial heat treating equipment, combining high product quality and high production with economy of operation and maintenance. Consult with them about your heat treating requirements. Drever Company, Bethayres, Pa. Phone: Wilson 7-3400.

DREVER INDUSTRIAL FURNACES

ENGINEERED TO YOUR PARTICULAR REQUIREMENTS

ENGINEERING AND MANUFACTURING FACILITIES AROUND THE WORLD THROUGH ASSOCIATES IN FRANCE, GREAT BRITAIN, GERMANY, ITALY, JAPAN AND INDIA

Which **Bearing** should you buy?

—They're dimensionally interchangeable, but dimension is only one of many factors to consider. At left, is a super-precision bearing, made to the most critical specifications and good for thousands of trouble-free hours of service in the proper application. This bearing is a waste of money and often a source of trouble in less demanding applications.

At right, a standard bearing suitable for applications where preload, run-out and tolerances are not too demanding.

Which should you buy? Let our bearing engineers help you. When you buy super-precision from Bearings, Inc., you get super-precision bearings in the manufacturers' original boxes — factory-fresh and incorporating the latest improvements. They are usually carried in stock and delivery is immediate.

If a standard bearing is best, you will get it fast from Bearings, Inc. And above all, when your Receiving Department checks the bearings received against your purchase order, you'll find you have received what you have ordered—exactly with no "just as good" substitutions!

Call the Bearings, Inc. branch nearest you NOW!

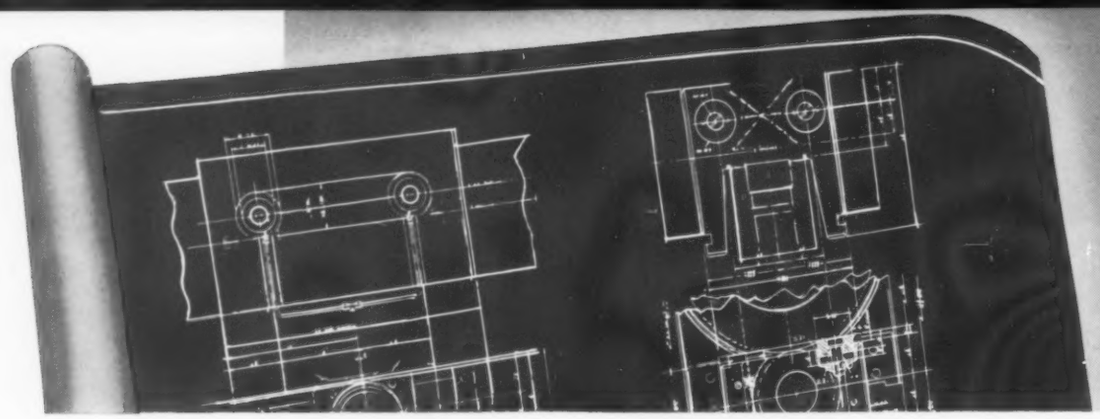
Providing bearing service in the North ➤ **BEARINGS, INC.**

DELAWARE: Wilmington • **ILLINOIS:** Neiman Bearings Co., E. St. Louis • **INDIANA:** Ft. Wayne • Indianapolis • Muncie Terre Haute • **MARYLAND:** Baltimore • **MISSOURI:** Neiman Bearings Co., St. Louis • **NEW JERSEY:** Camden • Newark **NEW YORK:** Balanrol Corp., Buffalo • Niagara Falls • **OHIO:** Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton Lima • Lockland • Mansfield • Painesville • Toledo • Youngstown • Zanesville • **PENNSYLVANIA:** Erie • Johnstown • Philadelphia • Pittsburgh • York **WEST VIRGINIA:** Charleston • Huntington • Parkersburg • Wheeling

and

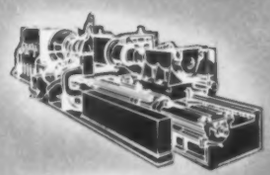
in the South ➤ **DIXIE BEARINGS, INC.**

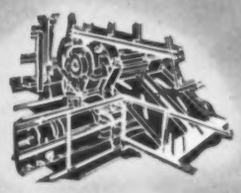
ARKANSAS: Little Rock • **FLORIDA:** Jacksonville • **GEORGIA:** Atlanta • **KENTUCKY:** Louisville • **LOUISIANA:** Baton Rouge New Orleans • **N. CAROLINA:** Asheville • Charlotte • Greensboro • **S. CAROLINA:** Greenville • **TENNESSEE:** Chattanooga • Kingsport Knoxville • Memphis • Nashville • **VIRGINIA:** Norfolk • Richmond • Roanoke

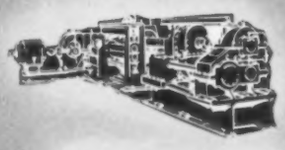


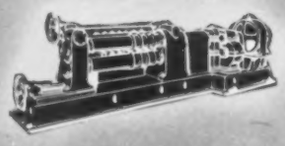
Blueprint of a new process

by "YOUNGSTOWN"

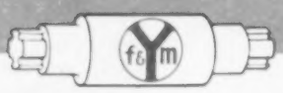








Complete Engineering
Contract Services
Rolling Mill Machinery
Special Machinery
Paralloy Rolls
Ductile Iron Rolls
Castings up to 100,000#



One of Many Major Developments for Industry during 75 YEARS of Service

Have you heard about Work Roll Shaping? It's a unique method for assuring uniform flatness of steel strip. Reports from users of installations already in operation indicate remarkable results. This is just one of the recent "Youngstown" developments which improve rolling mill operations. Complete information will be furnished, without obligation, on any of the following:

Hydraulic Work Roll Shape Control
Improves the quality of strip—economically

Automatic, Heavy Duty, Contour Roll Lathes
Modern design for templet or numerical control

New Carriage-Type Stretcher Levelers
Sizes from 10,000# to 4,000,000#. Fast, efficient

500 fpm—81" Sheet Scrubber Line
Cleans sheets up to 76" wide and .250" thick

New Rotary-Type Plate Scrap Chopper
Unique reciprocating design prolongs knife life

Coil Processors and Scale Breakers
New concept of coil processing and scale breaking

Other recent contracts range from complete turnkey installations to auxiliary components. Whatever the need—large or small—you benefit from "Youngstown" experience.

The Youngstown Foundry & Machine Co.

Youngstown 1, Ohio

Date-line Diary...

June 2

△ The Bureau of the Census reports that shipments of iron and steel castings in March, 1961, totaled 1,022,230 tons compared with 845,843 tons in February, 1961, and 1,373,636 in March, 1960.

△ Price of a key grade of scrap, in Pittsburgh, rose to $37 per ton, up $2 per ton from the previous month.

June 3

△ The AISI reported that steel production for the week ending June 3, 1961, totaled 2,052,000 net tons (about 72.0 per cent of capacity) compared with 2,077,000 tons one week ago (72.7 per cent of capacity) and 1,726,000 tons one year ago. Index of production was 110.1.

June 5

△ American Iron Ore Assn. reported that shipments down the Great Lakes in May, 1961, totaled 5,236,532 gross tons, compared with 12,475,201 tons in May, 1960. Shipments in 1961 to June 1, 1961, totaled 5,450,014 tons compared to shipments of 18,151,132 tons for the same period in 1960.

June 6

△ National Tube Div. of U. S. Steel announced a price reduction of $18 per ton for API grade X-52 pipe in $6\frac{5}{8}$ to $12\frac{3}{4}$-in. OD inclusive, on minimum carload quantities.

△ The Bureau of the Census reports that shipments of commercial steel forgings in April, 1961, totaled 95,641 tons, compared with 96,343 tons in March, 1961, and 116,717 tons in April, 1960.

June 7

△ Dealers' new car inventories dropped to 902,700 as of June 1, 1961, compared to the 1,045,000 cars in stock on June 1, 1960.

June 8

△ The AISI reports that the steel industry's payroll for hourly and salaried workers in April, 1961, totaled $291,967,656 compared to $298,129,844 in March, 1961. Total employed in April numbered 501,323 compared with 491,925 in March. Payroll cost per hr worked by hourly employees was $3.500 in April compared with $3.455 in March not including 47.1¢ per hr supplemental employee benefits. Average hours worked per week were 35.7 in April, 1961, compared with 36.7 in March 1961.

△ The Aluminum Assn. reports that shipments of aluminum sheet and plate in April, 1961, totaled 121,487,000 lb, compared with 124,231,000 lb in March, 1961, and 113,046,000 in April, 1960. Shipments of aluminum foil in April, 1961, totaled 18,270,618 lb compared with 22,286,574 lb in March, 1961 and 17,895,732 lb in April, 1960.

△ The Bureau of the Census reported that April, 1961, shipments of titanium mill products totaled 746,548 lb compared with 1,151,913 lb in March, 1961, and 534,742 lb in April, 1960. Production of titanium ingot in April, 1961, totaled 1,679,507 lb compared with 1,791,842 lb in March, 1961.

June 9

△ A Federal survey indicates that 1961 capital investment in new plant and equipment will be less than $34,500,000,000.

June 10

△ The AISI reported that steel production for the week ending June 10, 1961, totaled 2,042,000 net tons (about 71.7 per cent of capacity), compared with 2,052,000 tons one week ago (72.0 per cent of capacity) and 1,756,000 tons one year ago. Index of production was 109.6.

June 14

△ The Dept. of Interior limited oil imports into the area east of the Rocky Mts. to 670,933 bbl daily for the last six months of 1961, a reduction of 33,400 bbl per day.

△ The Bureau of Statistics reports that Canadian steel operation in the week ending June 10, 1961, totaled 124,479 tons compared with 127,395 tons same week last year.

△ The Business and Defense Service Administration reported that U. S. exports of crude aluminum in the first four months of 1961, totaled 97,891,000 lb compared with 242,440,000 lb in the like 1960 period. Exports of semi-fabricated aluminum shapes in the first four months of 1961, totaled 20,627,000 lb compared with 11,090,000 lb in the like 1960 period.

△ Imports of crude aluminum during the first four months of 1961, totaled 95,108,000 lb compared with 96,637,000 lb in the like 1960 period; imports of semi-fabricated aluminum shapes totaled 32,540,000 in the January through April, 1961 period, compared with 30,650,000 lb in the like 1960 period.

△ The Bureau of Mines reports that production of Pennsylvania anthracite in May, 1961, totaled 1,394,000 tons compared with 1,197,000 tons in April, 1961, and 1,262,000 tons in May, 1960.

June 15

△ The Bureau of Mines reported that consumption of scrap in April, 1961, totaled 4,667,000 gross tons compared with 4,449,078 tons in March, 1961; pig iron consumption in April, 1961, totaled 4,320,000 gross tons compared with 4,130,000 tons in March, 1961.

△ Treasury Secretary Dillon announced that the national debt is expected to rise to $295,000,000,000 during the fiscal year starting July 1, 1961. Congress has been asked to raise the current debt limit to $298,000,000,000, an increase of $5,000,000,000 above the present limit.

△ The Federal Housing Administration reported that applications for new home mortgage insurance totaled 227,000 in May, 1961, seasonably adjusted, up five per cent from April, 1961.

△ AISI reported that steel production in May, 1961, totaled 8,978,000 net tons, compared with 7,584,687 tons in April, 1961; steel production for the first five months of 1961, totaled 36,305,178 tons.

June 16

△ Major steel producers decreased prices of steel wire rope sold to jobbers by ten per cent.

June 17

△ The AISI reported that steel production for the week ending June 17, 1961, totaled 1,985,000 net tons (about 69.7 per cent of capacity) compared with 2,042,000 tons one week ago (71.7 per cent of capacity) and 1,775,000 tons one year ago. Index of production was 106.6.

June 19

Δ The Bureau of the Census reported that net shipments of aluminum pig and ingot in April, 1961, totaled 92,344,000 lb compared with 115,344,000 lb in March, 1961, and 119,217,000 lb in April, 1960. Shipments of aluminum mill products totaled 268,903,000 lb in April, 1961, compared with 281,258,000 lb in March, 1961, and 247,631,000 lb in April, 1960. Net shipments of magnesium mill products in April, 1961, totaled 1,341,000 lb compared to 2,172,000 lb in March, 1961, and 1,790,000 lb in April, 1960.

Δ The Commerce Dept. reported that personal income in May, 1961, rose to a seasonally adjusted annual rate of $413,700,000,000, a new record, and $2,400,000,000 above the April, 1961, rate.

Δ The Iron and Steel Board disclosed that maximum prices of British iron and steel products have been increased by one per cent, equal to approximately $1.40 per ton.

Δ The Japan Iron and Steel Federation reports that production of ingot steel in Japan in April, 1961, totaled 2,519,000 net tons; pig iron 1,383,800 tons.

Δ The Bureau of the Census reported that home building starts in April, 1961, were at a seasonally adjusted rate of 1,298,000, eight per cent above the April rate.

June 20

Δ The Aluminum Assn. reports that primary aluminum production in May, 1961, totaled 157,544 tons compared with 144,637 tons in April, 1961, and 175,863 tons in May, 1960.

Δ The Bureau of Mines reports that U. S. 1960 scrap consumption totaled 66,468,708 tons, compared with 66,061,516 tons in 1959; U. S. pig iron consumption in 1960, totaled 66,626,336 tons compared with 61,773,191 tons in 1959. Total U. S. imports of ferrous scrap in 1960, totaled 179,457 tons at $6,386,081, compared with 309,448 tons at $11,590,695 in 1959.

Δ Can Manufacturers Institute, Inc. reports that canmakers consumed 1,326,458 tons of steel in the first four months of 1961, an increase of 3.1 per cent compared with the like period in 1960. Aluminum cans totaled 11,923 tons.

Δ The Commerce Dept. reports that May, 1961, new orders for durable goods makers rose to a seasonally adjusted $14,900,000,000, up two per cent from April, 1961.

Δ Metal dealers are offering ¼ to ⅜¢ per lb discounts on refined copper, which is presently priced at 31¢ per lb.

June 21

Δ Treasury Secretary Dillon reported that the gross national product by the end of 1961 would reach an annual rate of $530,000,000,000. compared with the $515,000,000,000 rate projected for 1961.

Δ The Bureau of Mines reported that March, 1961, shipments of steel mill products totaled 5,000,000 tons compared with 4,300,000 tons in February, 1961. Imports of steel mill products totaled 211,000 tons and exports totaled 168,000 tons in March, 1961.

June 22

Δ The value of the Canadian dollar fell to 97¢ in U. S. money after the Canadian government announced its aim of promoting exports by reducing exchange rates.

Δ National Tube Div. of U. S. Steel announced price reductions from $15 to $18 per ton on various API grades, on minimum carload quantities.

Δ Major aluminum producers reduced prices by four per cent on certain extrusion billets.

Δ McLouth Steel Corp. announced that a $7,000,000 expansion program was underway to improve cold rolling facilities at its Gibraltar plant.

Δ The National Machine Tool Builders Assn. reports that net new orders of cutting and forming type machine tools in May, 1961, amounted to $50,300,000 compared with $47,650,000 in April, 1961. Shipments of cutting and forming type tools amounted to $67,800,000 compared to $53,700,000 in April, 1961.

June 23

Δ The ARCI reported that deliveries of new freight cars in May, 1961, totaled 3360 compared with 2933 in April, 1961, and 5931 in May, 1960. Orders in May, 1961, totaled 3666 compared to 2040 in April, 1961, and 2209 in May, 1960. Backlog of cars on order as of June 1, 1961, totaled 13,964 compared with 13,658 on May 1, 1961, and 36,106 on June 1, 1960.

Δ The AISC reported that shipments of fabricated structural steel in May, 1961, totaled 364,996 tons compared with 318,657 tons in April, 1961, and 320,108 tons in May, 1960. Bookings in May, 1961, totaled 391,703 tons compared with 309,400 tons in April, 1961, and 301,867 tons in May, 1960. Backlog as of May 30, 1961 totaled 2,457,795 tons.

Δ Assn. of American Railroads reported that freight carloadings in the week ending June 17, 1961, totaled 602,153 cars, compared with 593,304 cars the previous week and 649,503 cars the same week one year ago.

June 24

Δ The AISI reported that steel production for the week ending June 24, 1961, totaled 1,978,000 net tons (about 69.3 per cent of capacity), compared with 1,985,000 tons one week ago (69.7 per cent of capacity) and 1,739,000 tons one year ago. Index of production was 106.2.

June 26

Δ F. W. Dodge Corp. reports that total construction contracts in May, 1961, totaled $3,501,318,000 compared with $3,336,723,000 in May, 1960. May, 1961, index (1947–1949 = 100) was 257, compared with 261 in April, 1961, and 244 in May, 1960.

June 28

Δ The Labor Dept. reported that living costs in May, 1961, decreased to 127.4 per cent of the 1947–1949 average, down 0.1 per cent from the record level of April, 1961.

Δ The Bureau of the Census reported that April, 1961, shipments of nonferrous castings totaled 167,265,000 lb, compared with 171,115,000 lb in March, 1961.

June 29

Δ U. S. gold stocks rose $24,000,000 in the week ending June 28, 1961, reducing the year's losses to $217,000,000 and increasing U. S. bullion holdings to $17,550,000,000.

Δ The Aluminum Assn. reports that shipments of aluminum sheet and plate in May, 1961, totaled 132,832,000 lb, compared with 121,736,000 lb in April, 1961. Shipments of aluminum foil in May, 1961, totaled 20,039,338 lb, compared with 18,270,618 lb in April, 1961.

Δ The U. S. Government reports that May, 1961, exports totaled $1,600,000,000, one per cent above the April, 1961, level.

June 30

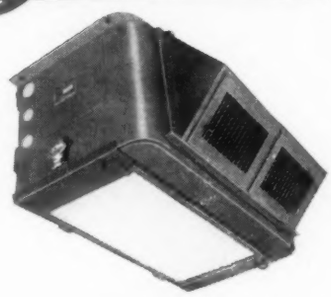
Δ American Iron Ore Assn. and AISI joint report shows receipts of iron ore in the U. S. in May, 1961, totaled 7,138,818 gross tons compared with 15,925,648 tons in May, 1960. Iron ore consumption in May, 1961, totaled 8,313,041 gross tons compared with 9,740,404 tons in May, 1960. Blast furnaces operating as of May 31, 1961, totaled 145 of the existing 255. On May 31, 1959, 173 blast furnaces were operating.

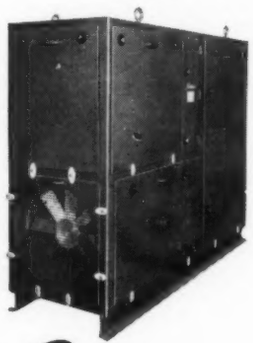
GET RID of profit-stealing heat!

Lintern

AIRE-RECTIFIERS KEEP THOUSANDS OF CRANE CABS COOL—

Even in Hot Locations Like This





This cab is Lintern air conditioned. Thousands of crane cabs and pulpits are. And the amazing thing is how little service is needed in spite of the extreme mill conditions which these air conditioners must overcome. Lintern equipment has been tested over soaking pits for more than 20 years. You can depend on it to perform well, increase operator efficiency, boost production, and net you a greater return on your capital investment.

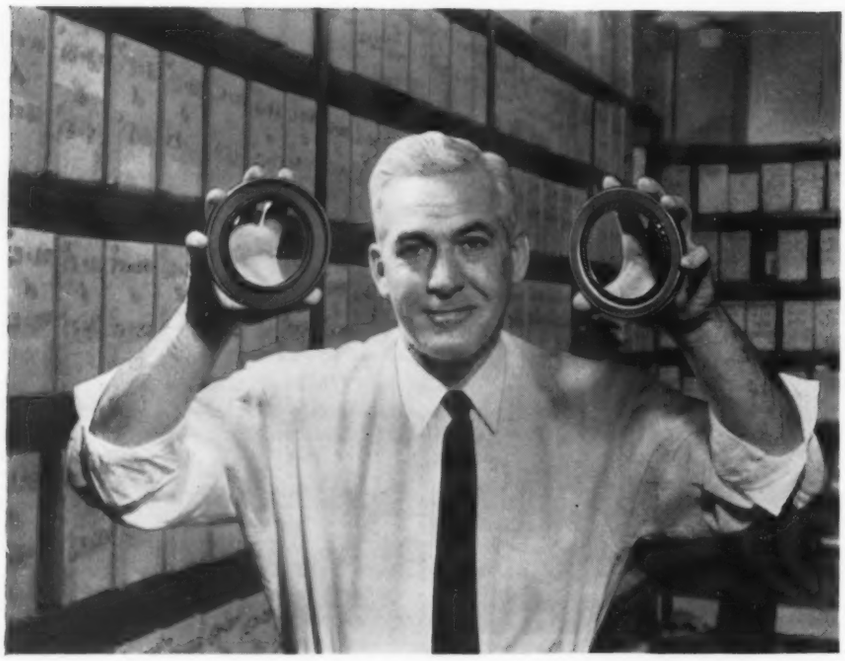
More Lintern

Aire Rectifiers cool more cabs and pulpits than any other make.

DISTRIBUTED BY LARCO, INC., Painesville, Ohio

ENGINEERED OIL SEALS

from Your Local Bearing Distributor



For positive bearing protection specify high-quality Garlock KLOZURE Oil Seals from one of the listed authorized bearing distributors.

NOW—you can draw from over 1800 standard stock items of Garlock KLOZURE* Oil Seals, and enjoy "off-the-shelf" delivery from the nearest of these authorized distributors:

ALABAMA
OWEN RICHARDS CO. ..... Birmingham (4)

ARIZONA
HELMS INDUSTRIAL SUPPLY ..... Phoenix
TUCSON BEARING CO. ..... Tucson

ARKANSAS
ALLIED ARKANSAS BEARING CO. ..... Little Rock

CALIFORNIA
AMERICAN BALL & ROLLER BEARING CO. ..... Oakland
BAY CITY BEARING CO., INC. ..... Los Angeles (Maywood)
MATERSON BEARING CO. INC. ..... San Jose
RELIABLE BEARING & SUPPLY CO. ..... San Bernardino

COLORADO
BEARING SERVICE & SUPPLY CO. ..... Denver (16)

CONNECTICUT
TEK BEARING CO. ..... Stratford

FLORIDA
BALL & ROLLER BEARING CO. ..... Tampa
FLORIDA BEARINGS, INC. ..... Miami (37)

GEORGIA
BEARINGS & DRIVES OF SAVANNAH, INC. ..... Savannah
DIXIE BEARINGS, INC. ..... Atlanta

IDAHO
WESTERN BEARINGS, INC. ..... Boise

ILLINOIS
BEARING HEADQUARTERS CO. DIV. OF RAY M. RING CO., INC. ..... Chicago (44)
BERRY BEARING CO. ..... Chicago Heights
GENERAL BEARINGS CO. ..... Chicago (16)
ILLINOIS BEARING CO. ..... Peoria

INDIANA
BEARING SERVICE CO. ..... South Bend

IOWA
IOWA BEARING CO. ..... Davenport

LOUISIANA
MONROE AUTOMOBILE & SUPPLY CO. ..... Monroe

MICHIGAN
DETROIT BALL BEARING CO. ..... Detroit (1)

MINNESOTA
MINNESOTA BEARING CO. ..... Minneapolis (3)
POWER SUPPLY CO. ..... Minneapolis (8)

MISSOURI
BEARING DISTRIBUTORS, INC. ..... Kansas City (10)
NEIMAN BEARINGS CO. ..... St. Louis (3)

MONTANA
BEARING SUPPLY CO. ..... Billings
MONTANA HARDWARE CO. ..... Butte

NEBRASKA
PRECISION BEARING & TRANSMISSION CO. ..... Omaha (2)

NEW MEXICO
MINE SUPPLY CO. ..... Carlsbad
SAN MATEO BEARING CO. ..... Grants

NEW YORK
SYRACUSE BEARING CO. ..... Syracuse
T. T. BEARING CO. ..... Rochester

NORTH DAKOTA
WESTERN BEARING & SUPPLY CO. ..... Fargo

OHIO
BEARING DISTRIBUTORS, INC. ..... Cleveland
BEARINGS INC. ..... Cleveland

OKLAHOMA
CLARK BEARING SPECIALIST & SUPPLY CO. ..... Tulsa

OREGON
BEARING SALES & SERVICE INC. ..... Portland
BEARING SUPPLY CO. ..... Eugene

TEXAS
COTTINGHAM BEARING CO. ..... Dallas
JOHNSTON BEARING & SUPPLY CO. ..... Houston
MIDCAP BEARING SERVICE ..... San Antonio
SEYMOUR BEARING CO. ..... Amarillo

UTAH
BEARING ENGINEERING & SALES CO. ..... Salt Lake City

WASHINGTON
BITCO INC. ..... Spokane

WISCONSIN
BADGER BEARING CO. ..... Milwaukee
WISCONSIN BEARING CO. ..... Milwaukee

GARLOCK

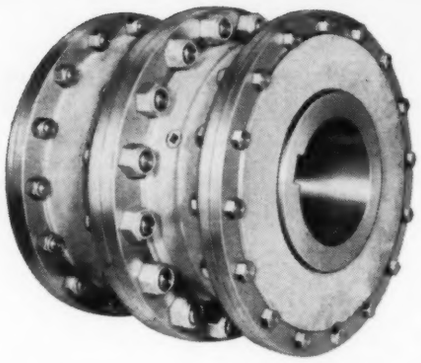
These listings are headquarters only, and many of the companies have branch outlets in your area. For more information, contact the nearest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada, or write Garlock Inc., Palmyra, N.Y.

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Co.

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products

*Registered Trademark



Heavy duty gear type

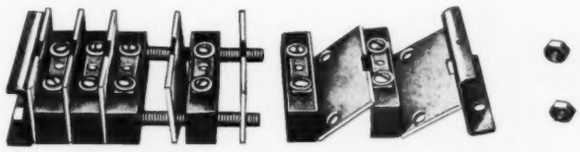
up to 6,000 hp per 100 rpm

Here's the coupling with all the muscle you need for heavy duty slow speed mill drives. The machined surfaces of each high grade steel casting are given a fine tool finish within strict tolerances. Waldron mill type couplings are easy to assemble, and seal tight against dust, moisture, and loss of lubricant. Standard sizes, 7" to 12". Horsepower per 100 rpm, 1,282 to 6,000. Maximum rpm, 1,950 to 1,200. Write for Bulletin S-1050 to Waldron-Hartig, a division of Midland-Ross Corporation, Box 791, New Brunswick, N. J. MR

WALDRON
Makes it easy to pick the right Couplings

HUNTER ADD-A-UNIT

Vitrified Porcelain
Fireproof Terminal Blocks
Heavy Duty



For rolling mill and open hearth cranes or other installations where high temperature is a critical consideration.

Performance proven in use by several large Pittsburgh District steel companies.

HUNTER SALES CORPORATION
311 Cypress Way, Pittsburgh 28, Pa.
Phone: Fieldbrook 1-2444

SPECTROCHEMICAL LABORATORIES

Analyze The Following:

METALS: Cast Iron, Ductile Iron, Meehanite, Low Alloy Steel, High Alloy Steel, Tool Steel, Aluminum, Brass, Bronze, Inconel, Monel, Zirconium Alloys, Titanium Alloys, White Metals, Die-Cast Alloys, Magnesium Alloys, Nickel-Base Alloys, Cobalt-Base Alloys.

CERAMICS: Refractories, Glass, Whitewares, Enamels, Slags, Ferrites, Ores, Clays, Minerals, Steatites, Titanates, Zirconates, Carbides.

MISCELLANEOUS: Fuel Oil Ash, Soils, Petroleum Products for inorganic elements, Engine Oils, Coal Ash, Chemicals, Corrosion Products, Welding Rod Coatings, Industrial Waste.

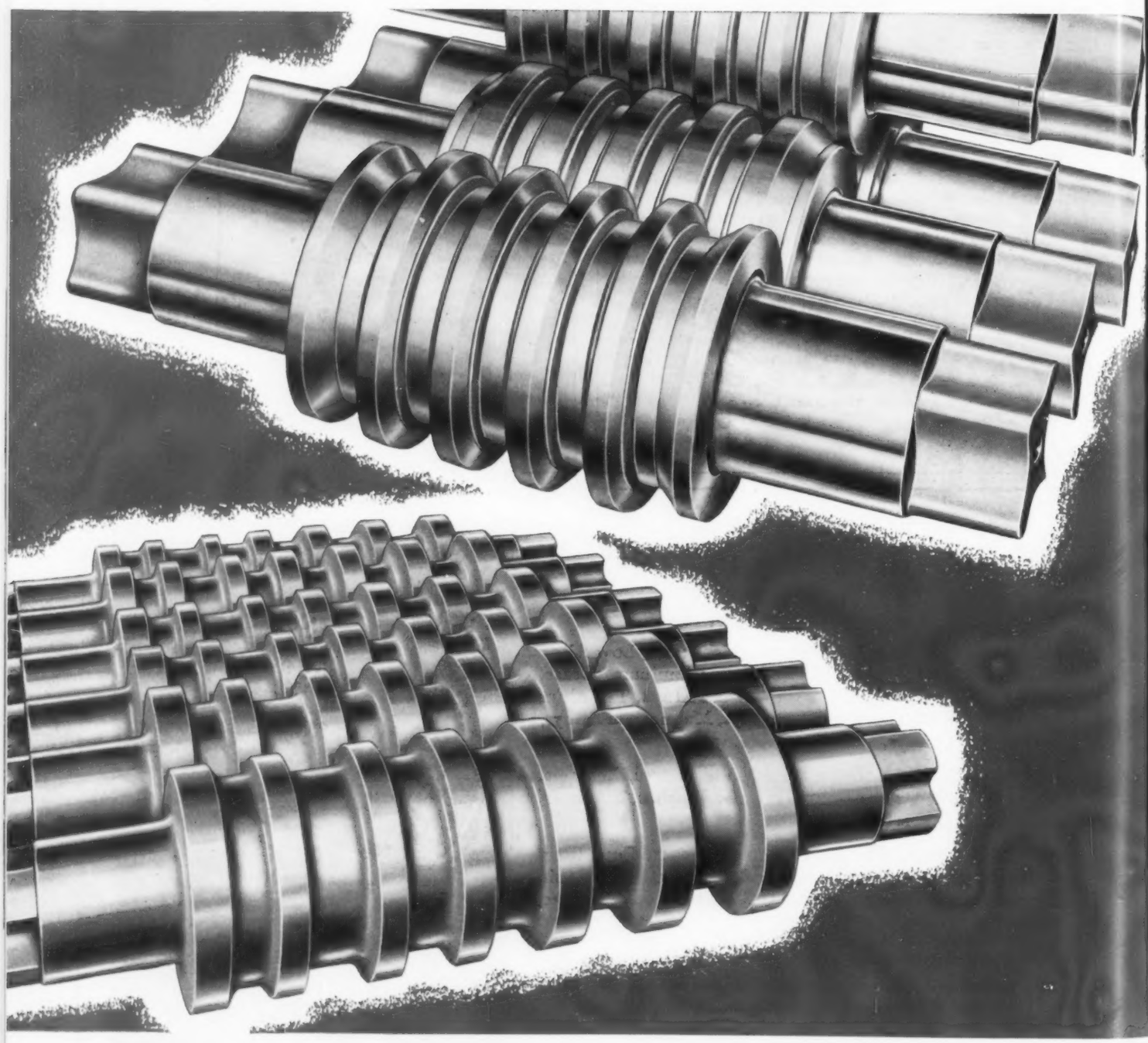
OVERNIGHT Analyses SERVICE is handled for customers as far as several thousand miles away.

Teletype PG-544, Phone FRemont 1-2345
or Write today for complete information.

SPECTROCHEMICAL LABORATORIES, INC.
P.O. Box 8781, Pittsburgh 21, Pa.

Ohio Rolls

Shaping Metal for all Industry



THE OHIO STEEL FOUNDRY COMPANY
LIMA, OHIO

OHIO IRON and STEEL ROLLS

Carbon Steel Rolls	Flintuff Rolls	Denso Iron Rolls
Ohioloy Rolls	Double-Pour Rolls	Nickel Grain Rolls
Ohioloy "K" Rolls	Chilled Iron Rolls	Special Iron Rolls
Nioloy Rolls	Forged Steel Rolls	

PLANTS AT LIMA AND SPRINGFIELD, OHIO. *Virtually at the center of the Steel Industry*

OR-49

Industry News...

AMBRIDGE PLANT ADDING STRETCH-REDUCING MILL

△ A stretch-reducing tube mill with the broadest size range and flexibility yet built into such a steel rolling unit will be part of the combination pipe mill facilities that National Supply Division of Armco Steel Corp. will install at its expanded and modernized Ambridge, Pa., plant.

The stretch-reducing mill will be supplied by the Aetna-Standard Division of Blaw-Knox Co. It will be used for the sizing and stretch-reducing of three types of pipe—seamless, continuous buttweld and electric weld—in an over-all size range from nominal ½-in. to 8⅝-in. outside diameter. The production capability of this 24-stand stretch-reducing mill will be 80 tons per hr or a maximum finishing speed of 2000 fpm.

The award to Blaw-Knox also includes cooling beds, conveyors, a hot saw, and a 4-stand semi-closing mill and a 4-stand buttwelding mill for the production of continuous buttweld pipe. In the production of the latter, the skelp first will be cold-formed on a new electric weld pipe mill which also will be installed at the Ambridge plant.

Part of a $95,000,000 capital expenditure program announced late in 1960 by Armco, the improvements will broaden National Supply's product lines as well as increase efficiency through consolidation of all its steel pipe and electrical conduit production at the Ambridge plant (which formerly specialized in making seamless tubular products).

COMPUTER TO CONTROL BASIC OXYGEN PLANT

△ Computer control for Great Lakes Steel Corp.'s oxygen steel furnaces plant will be supplied by TRW Computers Co., a division of Thompson Ramo Wooldridge Inc. Operation is scheduled to begin early in 1962.

In controlling furnace operation, the computer will take into account raw material and furnace characteristics, as well as specifications for the end product, and will control the quantity and chemical composition of the steel produced.

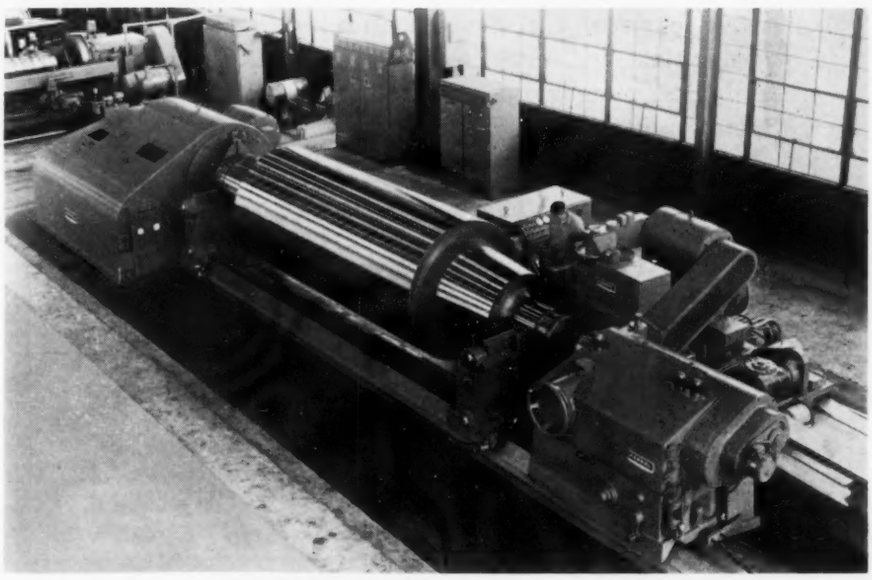
From the raw material characteristics, furnace characteristics and finished ingot specifications, the computer will determine the amounts and types of additives required. Next, the computer will control the heat generated within the vessel by controlling the flow rate and duration of the oxygen blow. In performing these tasks, the computer will ensure the maintenance of consistent operating practices, will minimize consumption of oxygen and raw materials, and will assure maximum production from the furnace consistent with high product quality.

Data accumulation capabilities of the system will permit the computer to relate finished ingot characteristics with the furnace data for specific ingots so that the best set of production conditions can be determined for subsequent batches. This is an "adaptive" control system that enables the computer's control program to be updated automatically as more is learned about furnace operation.

▲

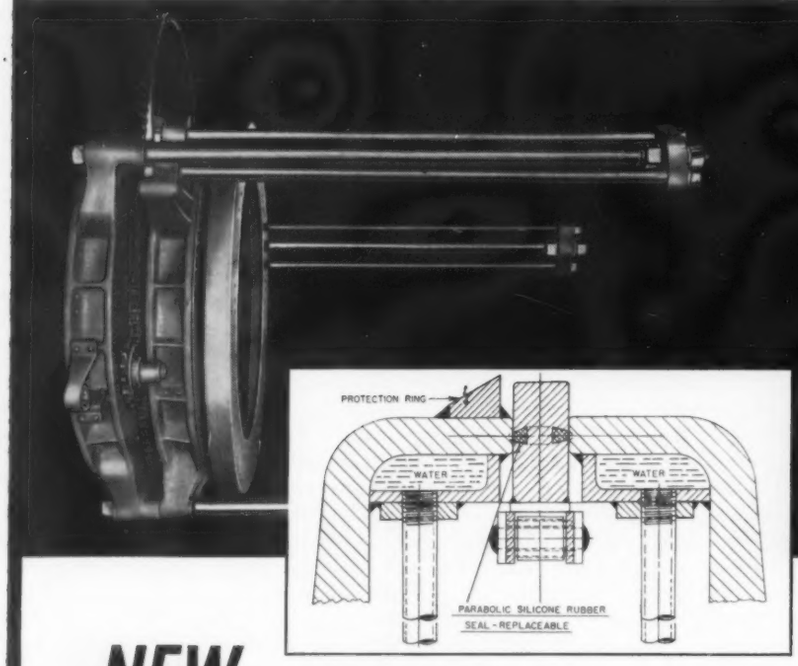
ROLL GRINDER AT WORK IN UNITED PLANT

A new large roll grinder has been installed and is now operating at the Vandergrift, Pa., plant of United Engineering and Foundry Co. The machine is mounted on a 900-ton inertia block of solid concrete. The cast-steel roll being ground measures 72 in. in diameter, 14 ft-2 in. in body length, and 24 ft-9 in. over-all. When finished, the roll will weigh 238,000 lb. The machine is capable of grinding rolls from 11 in. to 81 in. in diameter, and in lengths up to 30 ft. It also will support 200 tons on centers and can be extended to grind rolls up to 40-ft long. The grinder was built by Farrel-Birmingham Co., and incorporates such design features as the trunnion tilting infeed and crowning device which insures positive infeed and withdrawal of the grinding wheel without backlash. Another refinement is the semi-automatic wheel infeed which is designed to compensate for wheel wear by feeding the wheel into the work at a constant controllable rate, or to provide for optimum stock removal by maintaining a constant load on the grind wheel motor. The main wheel carriage is split allowing the upper section to be rotated. This upper section has its own special ways which can be adjusted to the desired taper and locked in place, allowing tapered necks on rolls to be ground using the main wheel head with the same size grinding wheel and horsepower used for straight grinding.



World's First

Water-Cooled, Silicone Rubber-Seated GOGGLE VALVE



NEW... GAS-TIGHT Service for High Pressure Furnaces

Designed for use between dustcatcher and washer, this valve features parabolic silicone rubber seats in the goggle plate, and water cooled flanges. Design provides a tighter, more gas-proof seal than is possible with metal-to-metal seals. *Write for Bulletin V-200.*

BAILEY *Thermal Expansion* GOGGLE VALVES

WILLIAM M. BAILEY COMPANY · 1221 BANKSVILLE ROAD · PITTSBURGH 16, PA.

SIEMAG COMPLETES NEW MILL BUILDING PLANT

△ Siemag Siegener Machinenbau GMBH has announced completion of its new plant in which wide strip hot finishing trains and cold tandem mills will be machined and erected.

United Engineering and Foundry Co. will provide information and technical support to assist Siemag in the field of rolling mill construction.

Three wide hot strip finishing trains and a 56-in. cold tandem mill are presently on order.

The new plant erected at Dahlbruch, West Germany, has equipment for handling and machining of housings of up to 250 tons each.

GE EQUIPPING TC&I STRIP REDUCTION MILL

△ A six-stand tandem cold strip reduction mill being built for United States Steel Corp.'s Tennessee Coal and Iron Division at Fairfield, Ala., will be equipped with General Electric Co. drives and controls.

Features of the new mill—designed by Tennessee Coal & Iron Division and Blaw-Knox Co., in conjunction with General Electric—include static excitation and automatic threading which are advanced beyond those previously used on a tandem cold strip reduction mill.

These devices will control the entry end where the coil will be automatically received, weighed and prepared for the mill. Once on the entry uncoiler, the strip is threaded into the stands where camber sensors on the side guards produce a signal to control screwdowns on work rolls to facilitate proper threading of the mill.

Static excitation makes use of silicon controlled rectifiers (SCR's) for all motor and generator fields. The SCR is a semi-conductor device that acts like a thyratron tube in adjusting d-c voltage through phase-controlled firing circuits to provide the adjustable voltage required for excitation. It has an extremely fast response time, needs little maintenance and has virtually unlimited life.

The control will provide transistorized static switching to handle all normal mill operating functions such as starting, stopping and jogging. A rate reference replaces the

"PASSING THE BATON"—FROM WHITING TO WHITING

The big Whiting Distributing Ladle has been storing the melt. Slag, rising to the top, has hardened to form a natural lid and retain the heat below. Now the "baton" — a stream of slag-free metal — is passed through the outside teapot spout into a Whiting Pouring Ladle with bottom tap for final relay to the molds.

This scene is typical of efficient foundry operations throughout the world. Whiting engineers, practical foundrymen themselves, have designed more than 200 types and models of metallurgical ladles to reduce costs, speed output and improve casting quality in every pouring operation. If you have a special need, they'll design a special ladle to meet it precisely. And there is no charge for this service. See your local Whiting rep or write direct.

FREE: Bulletin FY-163-R, *WHITING LADLES.* Forty pages of illustrated ladle models and accessories to cut your casting costs. Write for it today. *Whiting Corporation, 15655 Lathrop Avenue, Harvey, Illinois. In Canada: Whiting Corporation (Canada) Ltd., 350 Alexander Street, Welland, Ontario, Canada.*

90 OF AMERICA'S "FIRST HUNDRED" CORPORATIONS ARE WHITING CUSTOMERS

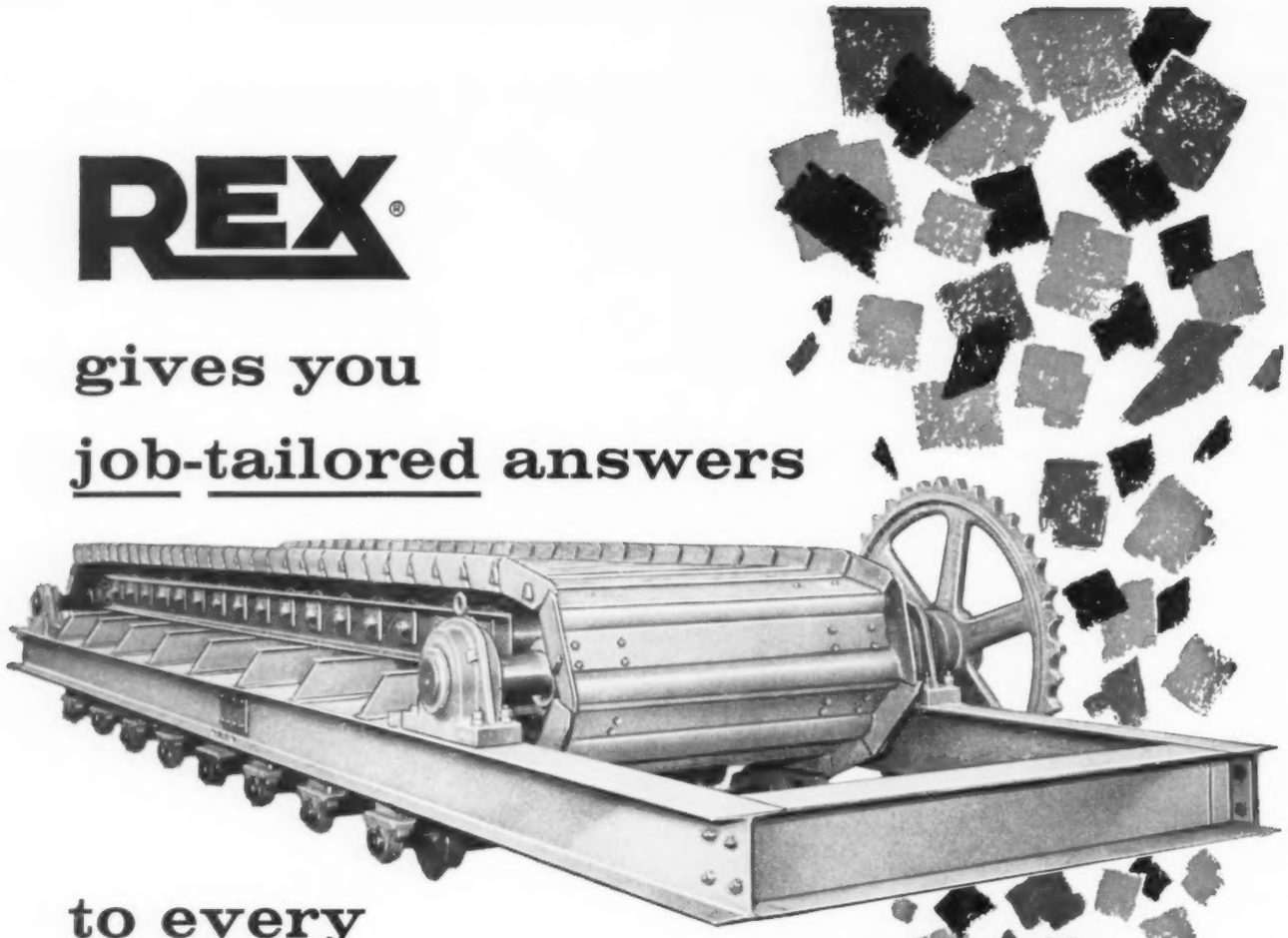
WHITING®

FOUNDRY EQUIPMENT

MANUFACTURERS OF CRANES; TRAMBEAM® HANDLING SYSTEMS; PRESSUREGRIP; TRACKMOBILES®; FOUNDRY, RAILROAD, AND SWENSON CHEMICAL EQUIPMENT

REX®

gives you job-tailored answers



to every apron feeder problem

Whatever you are feeding—broken, crushed or fine material—whatever volume or speed you require—call your CHAIN Belt Specialist. He has the experience, and the most complete line of apron feeders at his finger tips. Therefore, he is free to help you select a feeder that's tailored to meet your specific requirements. No job is too small or too large. The feeder he helps you select will give you the efficiency, economy and dependability you want.

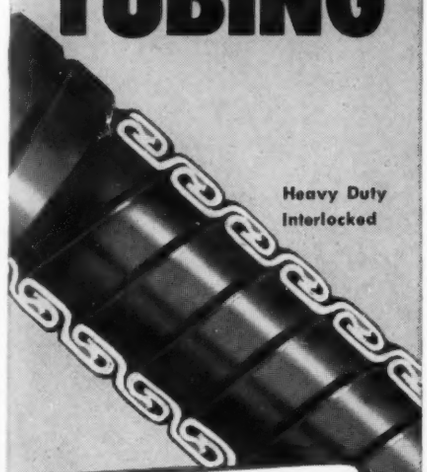
It will assure you years of accurate feeding, with savings in power, maintenance and replacement costs—and new freedom from down time.

Make sure you select a feeder tailored to your specific needs. Write CHAIN Belt Company, 4693 W. Greenfield Ave., Milwaukee 1, Wis. In Canada: Rex Chainbelt (Canada) Ltd., Toronto and Montreal.

REX®
CHAIN BELT COMPANY

A call to CHAIN Belt adds a man to your staff, but not to your payroll.

FLEXIBLE TUBING

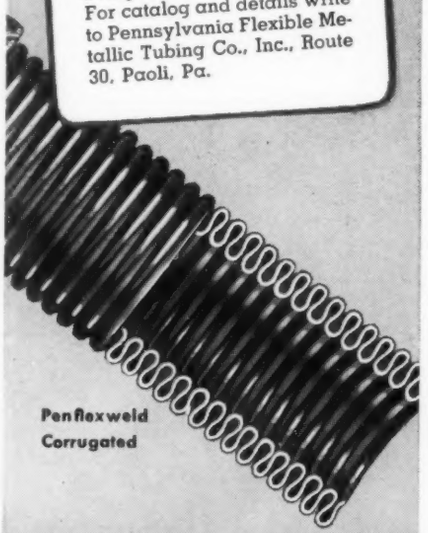


Heavy Duty Interlocked

RUGGED AND STRONG FOR LASTING SERVICE

. . . that is Penflex Flexible Tubing. Especially engineered for punishing industrial service . . . to defy abrasion, crushing, heat in conveying liquids, chemicals, powders, granular material, semi-solids.

Penflex makes all types and sizes (1/8" to 24" I.D.) for every industrial application. For catalog and details write to Pennsylvania Flexible Metallic Tubing Co., Inc., Route 30, Paoli, Pa.



Penflexweld Corrugated

PENFLEX

TIGHT AS A PIPE BUT...

FLEXIBLE

conventional motor-operated rheostat while logic circuits take the place of control relays.

Throughout the rolling of a coil, thickness of the finished strip is controlled by an automatic gage control system using X-ray gages installed after stands 1 and 6.

Records of strip thickness—i.e., whether the strip is on or off gage—are recorded on an automatic data accumulator. The logger also records and "remembers" the weight and length of each strip rolled.

Roll separating forces are measured at each stand by load cells.

The mill has been designed for easy conversion to completely automated operation using punched cards or a digital computer to program the entire process.

The mill will handle strip from 18 to 37-in. wide and 0.070 to 0.106-in. thick. The electric equipment will be capable of reducing the strip to thicknesses ranging from 0.006 to 0.015 in. at speeds as high as 7000 fpm.

The 20 main drive motors total 32,000 hp. Twelve screw-down motors total 900 hp. Direct current power is supplied by two motor-generator sets of 12,800 and 13,200-kw ratings. Other General Electric equipment for the mill includes switchgear, master unit substations and load center substations.

LINDE OPERATING NEW PUEBLO OXYGEN PLANT

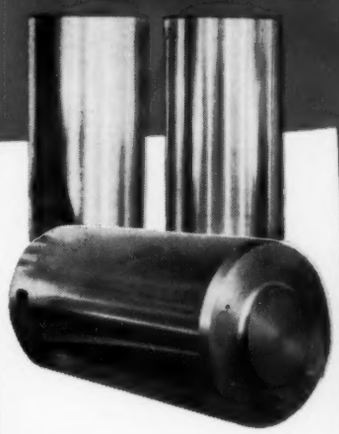
△ A 280-ton-per-day oxygen plant was recently put into operation at Pueblo, Colo., by Linde Co., Division of Union Carbide Corp. Designed to meet the increased requirements of Colorado Fuel and Iron Corp., a major portion of the new plant's output will be used in CF&I's basic oxygen steelmaking units which are currently nearing completion.

The two basic oxygen furnaces which are being added to CF&I's Pueblo plant will be capable of producing over 100,000 tons of ingots annually to replace or expand older existing facilities.

CF&I has also done extensive work, in cooperation with Linde, on blast furnace applications for oxygen. Tests using natural gas in the blast have been conducted at Pueblo for nearly a year, and the company is planning to start up

RED CIRCLE Rolls ALLOY-CHILLED

Hyde Park RAMS



for all types of HYDRAULIC EQUIPMENT

Hyde Park Rams are available in Chilled or Alloy Iron.

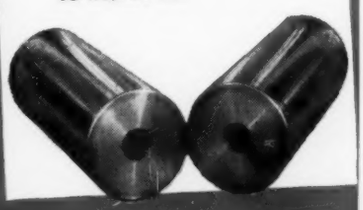
Furnished in hardness range to meet your specification . . . ground to your required size.

On your next replacement of Rams—or for new equipment—consult us. Our engineers will be glad to assist you.

Red Circle Rolls for every Purpose

Rolling Mill Equipment

Gray Iron Castings up to 80,000 lb.



Hyde Park

FOUNDRY and MACHINE CO.

HYDE PARK

Westmoreland County, Pa.

Rolls

Rolling Mill Equipment

Gray Iron Castings

the first major commercial-scale test of blast furnace oxygen and natural gas in the near future.

In addition to improving the over-all cost and efficiency of blast furnace operation, oxygen-natural gas enrichment of the blast will increase CF&I's hot metal capacity.

ORE BRIDGE FEATURES EQUIPMENT BY DRAVO

△ A new 15-gross-ton ore bridge being constructed for the Duquesne, Pa., works of United States Steel Corp. will be equipped with a man trolley, trucks and other mechanical equipment designed and fabricated by Dravo Corp.

The structure, which will have a 226-ft span, is being built by U. S. Steel's American Bridge Division to replace an existing bridge and is scheduled for completion this year.

Dravo is supplying the man trolley, four sets of single-rail eight-wheel trucks, four Gale Guard rail clamps, four six-ft-stroke hydraulic buffers and gate machinery for the hoppers.

The trolley, which weighs 200,000 lb with bucket and ore, will rock back and forth at speeds up to 800 fpm. The bucket, which will have a capacity of 187½ cu ft, will be hoisted at speeds up to 300 fpm and lowered at speeds up to 400 fpm.

Because the bridge will operate on a three-degree curve, the trucks are pivoted. With two motors at each corner and all wheels driven, the bridge will travel at a speed of 75 fpm.

Protection against wind damage will be provided by the spring-set rail clamps, which hold the structure firmly in winds of more than 100 miles an hour. The clamps engage automatically when wind velocity exceeds 35 miles an hr or when power is cut off.

The hydraulic buffers, mounted two at each end of the trolley runway, insure safe stops of the trolley and guard against over-run.

DOFASCO ADDS SCRUBBER TO OXYGEN FURNACES

△ Dominion Foundries and Steel, Limited has recently installed a venturi scrubber gas cleaning system on oxygen steelmaking furnaces.

According to Chemical Construction Corp., designers of the system, this marks the fifth venturi scrubber installed at Dofasco.

A new design feature of the gas cleaning system is an automatically controlled damper in the throat of the scrubber which permits operation at maximum gas cleaning efficiency at any gas volume up to 180,000 cfm.

Dust is collected as a slurry and is piped to another part of the plant for reclamation.

WESTINGHOUSE EQUIPS AUTOMATIC PLATE MILL

△ A 134-in. reversing universal plate mill at Republic Steel Corp.'s Gadsden, Ala., works is the first such mill in the industry to combine in-line process computer control with punched card programming. The mill programs rolling schedules up to 15 passes by a Westinghouse Electric Corp. control system similar to the six now functioning in domestic steel or aluminum plants. The

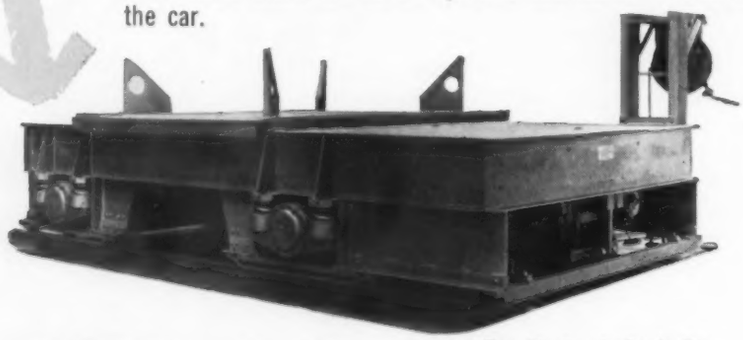
Tape Recording

Chart Recording

Atlas Builds Electronic Scales for -

Blast furnace scale cars, Coke weighing, Scrap bucket charging

This 60-ton scale car handles scrap buckets from the scrap yard to electric furnaces. For safety, the operator controls the car movement from a remote location. The electronic scale dial is mounted where the crane operator can watch it while loading the car.



60-Ton Electronic Scale Car

ATLAS CAR & MFG. CO.

1100 IVANHOE ROAD / CLEVELAND 10, OHIO

Lou Krakowski, General Superintendent of the Harrison Sheet Steel Company, is a guy who makes no bones about what he wants. It's service! And, for twenty years, he has been getting what he considers the best . . . Cities Service.

Turning out, among many other things, 125 steel desks a day, he wants complete and dependable lubrication service. One of the many Cities Service products he uses to get this job done is Trojan H-2 grease. For general greasing on all equipment, multi-purpose Trojan H grease has a wide range of application. And, because of the variety of jobs Trojan H grease does, it reduces his necessary lubrication stocks.

If you have to *get it on the line* . . . call your nearest Cities Service office . . . or write Cities Service Oil Company, 60 Wall Street, New York 5, N. Y.

CITIES SERVICE
QUALITY PETROLEUM PRODUCTS

computer is a digital system specifically developed for industrial in-line application.

The computer monitors roll pressure gage and X-ray thickness gage measurements to automatically predetermine mill settings before each pass. In addition, the computer automatically controls slab elongation in a single pass roughing stand to control width of skelp furnished by broadside rolling in the reversing mill.

The control system automatically directs the positioning of the roughing and main mill screwdowns, side guides and edger adjustments once information from the punched cards passes into the control system. Furthermore, it controls mill and table speed, draft compensation and cycle operation.

Also, the control system permits the operator to assume manual control at any point in the rolling cycle, and then to return the operation to automatic to complete the sequence.

Other equipment supplied by Westinghouse includes main drive and auxiliary motors totalling 15,500 hp, power supply, motor-generator sets, fans and blowers and associated equipment. The mill was designed and built by Mesta Machine Co.

FORD AWARDS COKE OVEN CONTRACT TO KOPPERS

△ Koppers Co., Inc., has received a contract from Ford Motor Co. to rebuild a battery of 61 coke ovens at its Rouge plant. An existing battery will be dismantled and the new ovens constructed on that site.

The new coke battery will consist of 61 Koppers-Becker gas-gun type ovens to be underfired with blast furnace gas exclusively. Construction of this battery is scheduled for completion early in 1962.

GE DESIGNS AUTOMATIC CRANE CONTROL SYSTEM

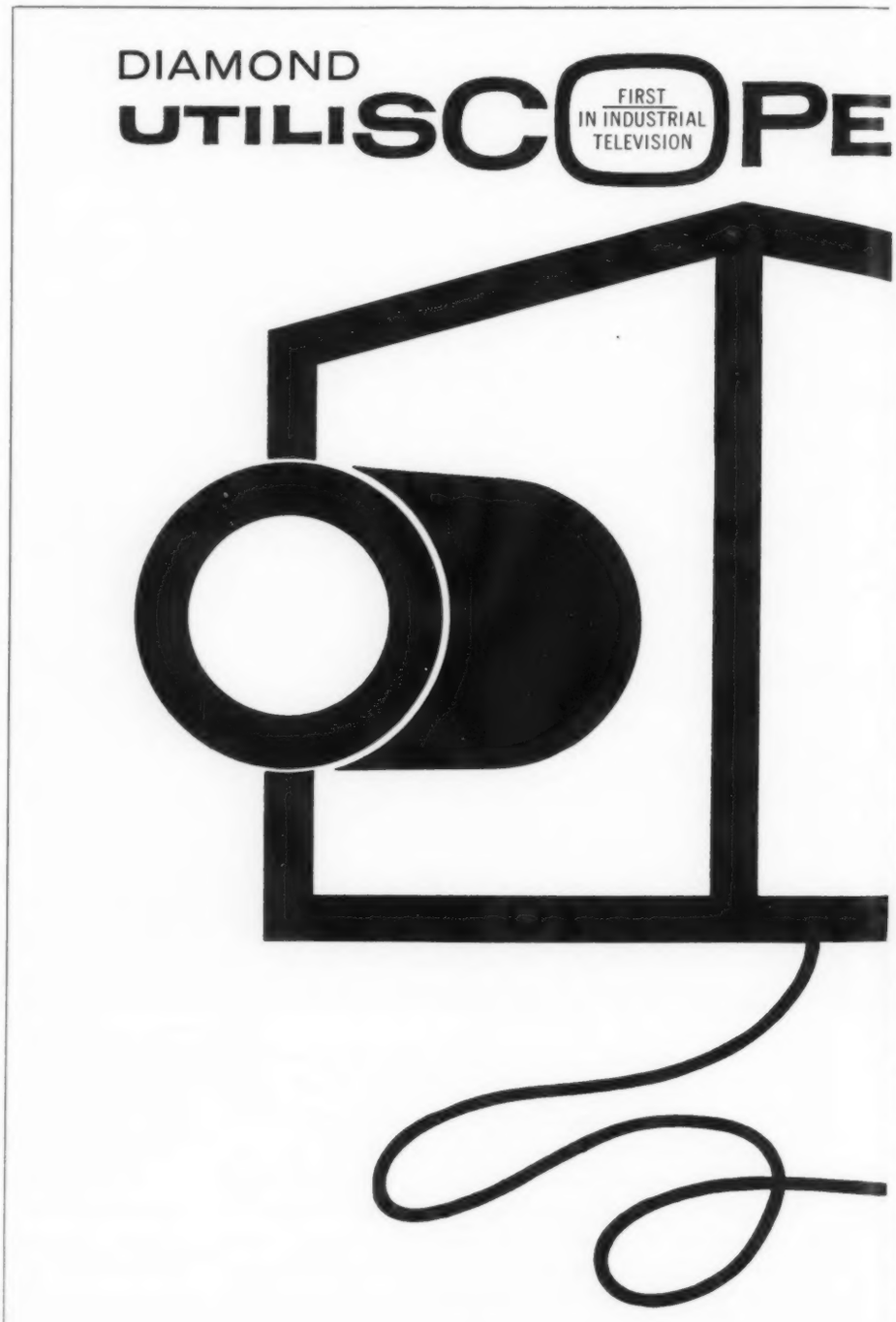
△ Automated crane equipment, equipped with a huge C-hook and designed to pick up 15-ton coils in an Ohio steel mill, will be governed by General Electric Co. controls. The completely automated crane control system, which will move coils from the production line to storage areas with minimum human assistance has been shipped from General Electric's Industry Control Department, Salem, Va.

With the new control program, the operator merely selects the size of coil to be moved, and presses the start button. From this point, the crane operates automatically. It moves to the pick-up location, descends, bridges forward to insert the hook into the coil, and then hoists the coil. It travels to the predetermined storage area, deposits the coil and returns to its homing station.

The automatic program control was applied to an existing d-c crane installation used to move coils from a bander to either a storage conveyor or an upender for storage.

Logic and sequencing of crane operations are regulated by solid-state control equipment. Composed of easily replaceable sealed static plug-in modules, each control function is mounted in pull-out drawers for greater accessibility.

Hoist, bridge and trolley motions are under automatic control. Motion is sensed by selsyn transmitters coupled to bridge and trolley motions and to the shaft of the hoist



motor through gearboxes. These drive selsyn receivers within the control panel.

Each programmed motion is ordered sequentially by switching to the proper transmitter through logic circuitry.

A preset plugboard bank within the magnetic control allows variation and adjustment of slowdown and stop points. Thus the programmed control will be adaptable to new storage layouts and destination points.

Auxiliary control within the installation allows drive motors to be slowed to 25 per cent of rated speed.

The operator chooses the storage destination for each coil through a selector switch. Following each delivery, the crane hook raises and the crane bridge returns automatically to its "home" station above the coil bander.

U. S. STEEL REPLACES GARY NO. 4 BAR MILL

△ United States Steel Corp. has replaced the former 10-in., No. 4 bar mill at Gary with a 12-in. mill.

The mill is now producing rounds in coils and cut lengths in sizes ranging from ½ in. to 1¼ in. in diam. The coils are some of the heaviest produced in the industry, weighing up to 1900 lb each. Carbon bar flats, automotive alloy spring steel flats and carbon steel concrete reinforcing bars also are available from this unit.

The mill will produce a full range of quality bar products including cold drawing, cold heading and cold extrusion types.

The company points out that increased demand for larger coils stems at least in part from economies which can be realized by producers of parts made from coiled bar stock. The larger coils permit longer production runs with less nonproductive downtime.

The new mill at Gary consists of 16 stands and will produce bar products at a rate in excess of 2000 fpm.

One of the ways a higher-quality product has been achieved is through installation of rolling stands which adjust to allow the steel bars to pass through vertical and horizontal rolls in a straight pass line.

BEGIN DELIVERING PLATE HANDLING EQUIPMENT

△ The Birdsboro Corp. has started delivery of plate handling equipment for Alan Wood Steel Co.'s new 110-in. rolling mill.

The equipment will include the country's first disk type cooling bed which will measure 90-ft wide by 114-ft long. Compared with the conventional grid bed, the disk type will provide better, more uniform cooling of the finished plate.

The fact that there will be more open space in the bed than there is with a grid type bed, will improve cooling effects. Bed speed can be regulated at 4 to 12 fpm.

Other handling and processing equipment included under the contract consist of: a plate parting shear with 1½ in. × 110-in. plate capacity, two transfer run-in tables, a fast plate transfer chain conveyor, a plate leveler, two leveler approach tables, two cooling bed run-in tables, two cooling bed run-out tables.

A front end crop shear, a dividing and back end crop shear, a shear gage and two gage tables, an overhead plate transfer, and a plate piler are also included.

"TAILORED" FOR THE TOUGH TESTS OF IRON AND STEEL

Closed-circuit television for iron and steel mill applications takes a "toughness" you'll find only in Diamond Utiliscope. Despite extreme heat, magnetic dust, vibrations or shock, Utiliscope provides reliable and accurate viewing of blast furnace and coke oven interiors plus a whole range of rolling and finishing operations . . . all from one safe, central control point. Regardless of *your* application, there's a Diamond Utiliscope System to help you save money by improving operations. The coupon below will bring complete information.

Diamond® Electronics

Division of Diamond Power Specialty Corporation

Diamond Electronics • Lancaster, Ohio

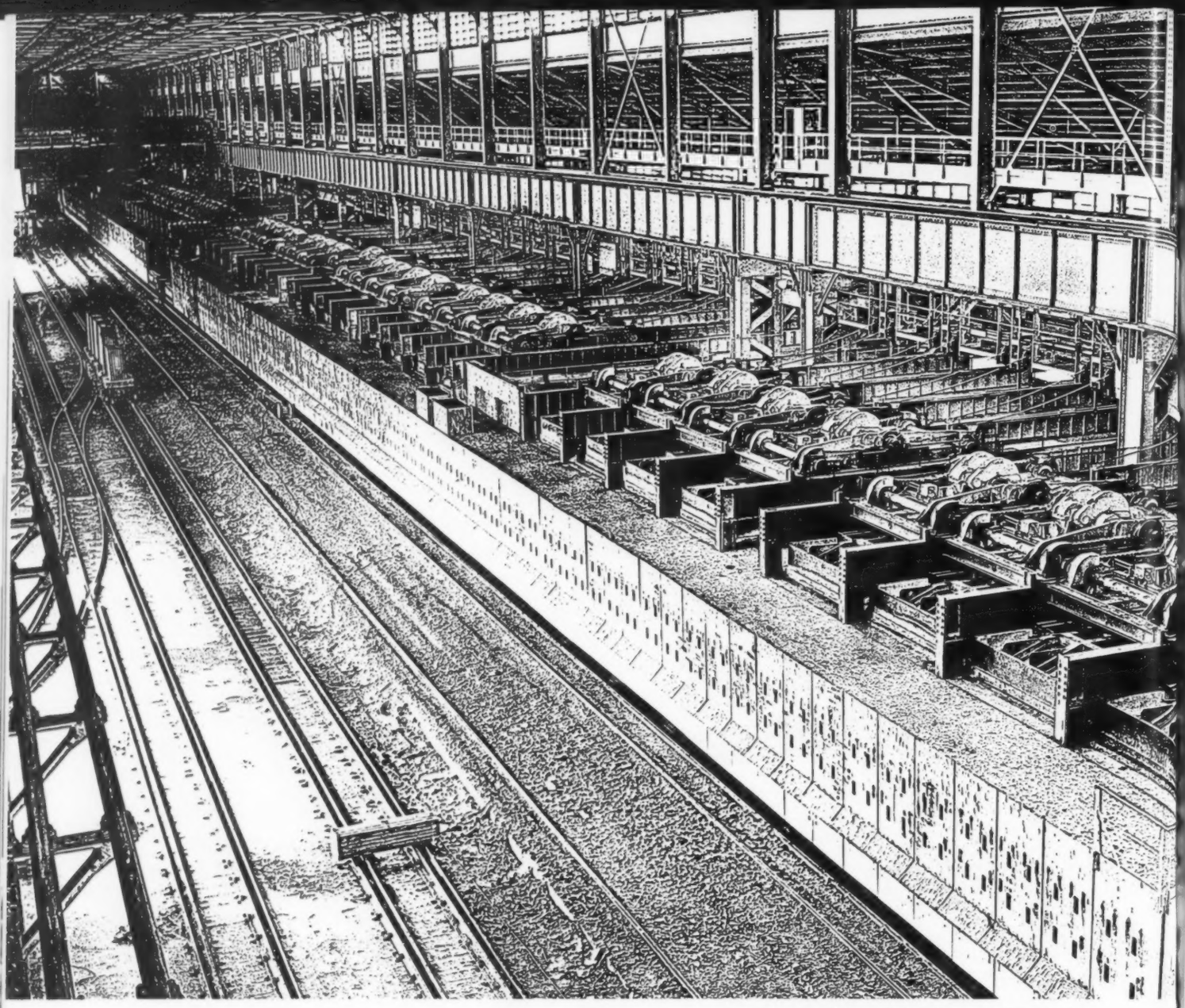
Please send complete information on how Diamond Utiliscope can help reduce operating costs and improve operations

Name_____

Title_____

Company_____

Address_____

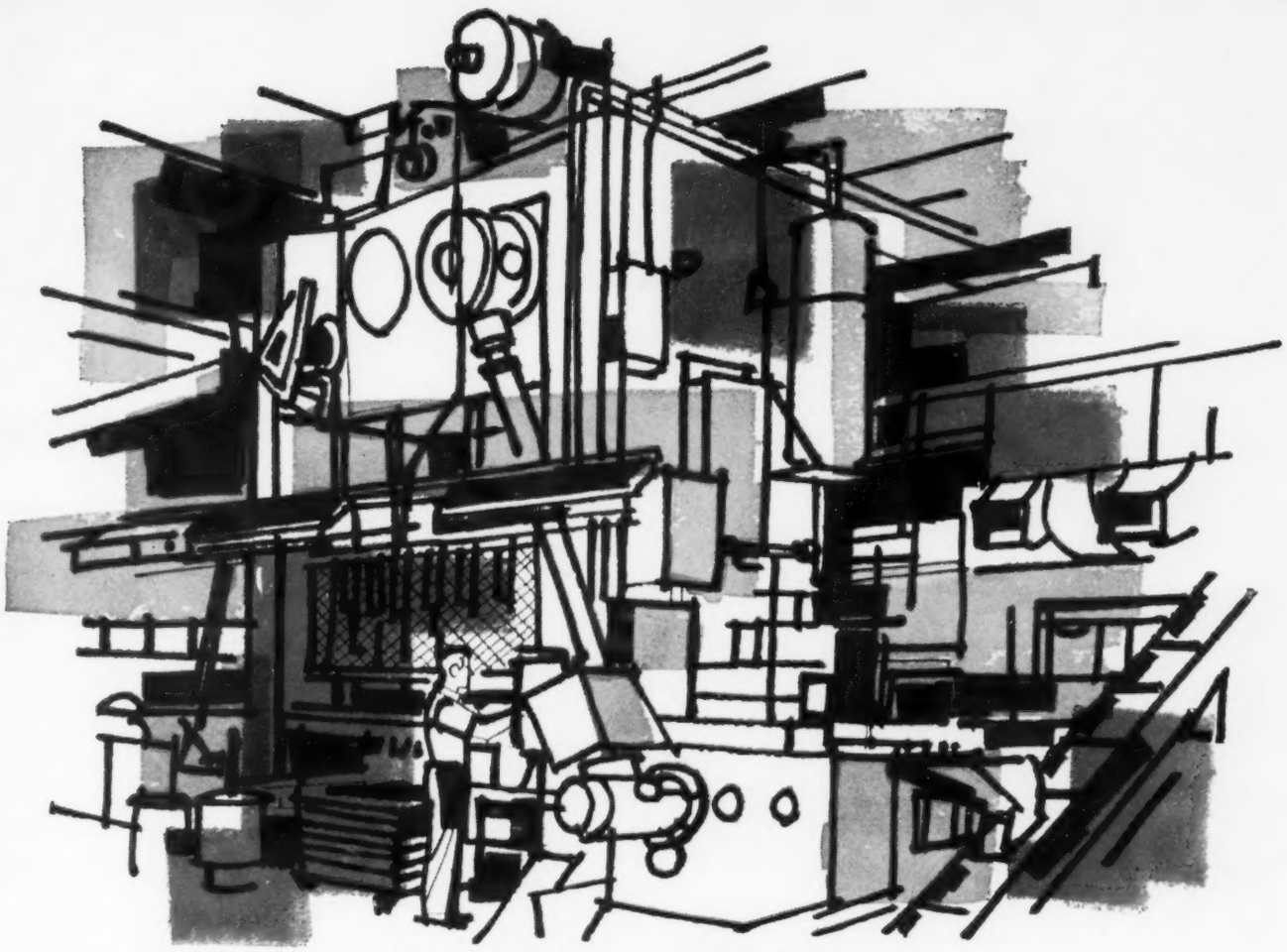


Courtesy of Gary Works, U.S. Steel Corporation

Gets them out the back door (750 tons/hr) This is the largest installation of soaking pits (48) ever built at one time. Engineered by Surface, it will heat an average of 750 tons per hour. At peak capacity, it loads the ingot buggies at a rate of 1200 tons per hour. A dual recuperator system applies the maximum amount of heat where it belongs—inside the pit. Address inquiries to 2404 Dorr St., Toledo 1, Ohio.

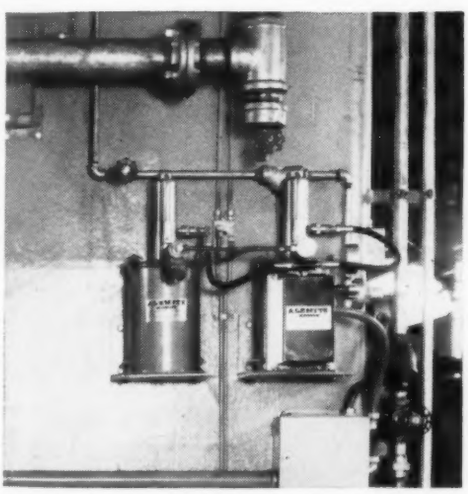
SURFACE

SURFACE COMBUSTION, Toledo 1, Ohio/ a division of Midland-Ross Corporation MR



ALEMITE ACCUMATIC SYSTEM LUBRICATES 300-TON PUNCH PRESS

Automatically...in seconds!



An Alemite Accumatic Centralized Lubrication System lubricates the key points on this 300-ton, 20-foot high Punch Press which can produce 1200 completed stampings per hour at 25 strokes per minute, based on 80% efficiency.

Complete with pump, metering valves, supply lines and controls, this Accumatic system offers all these advantages: It automatically meters out the exact amount of lubricant needed at each bearing on a predetermined cycle . . . never over- or under-lubricates. Guarantees lubrication of those out-of-the-way bearings frequently overlooked; protects against bearing wear due to neglect. Services *all* bearings in a single operation . . . in seconds . . . while the machine is running eliminating work stoppage . . . adding production hours to each day.

This installation is typical of the versatility and wide range of Accumatic's precision lubrication . . . typical of how Alemite's experience and products work together to provide the right lubrication system for machines of all types and sizes. Today, find out how Alemite and Accumatic can do a *big job for you,* too! *Send for free illustrated literature . . . or contact your Alemite representative.*

Symbol of SW Excellence

ALEMITE DIVISION
STEWART-WARNER CORPORATION

In Canada: Stewart-Warner Corporation of Canada Ltd., Belleville, Ontario

Dept. F-71, 1850 Diversey Parkway, Chicago 14, Illinois

WELLMAN

CRANES

One of two Wellman 10-ton Electric Overhead Travelling Magnet Beam Piling Cranes specially designed and constructed to pick up beams and stack them in neat piles suitable for loading into bolster wagons.

Each crane is capable of handling beams ranging in size from 8 in. x $5\frac{1}{4}$ in. x 17 lbs. per foot to 36 in. x $16\frac{1}{2}$ in. x 260 lbs. per foot varying in lengths from 16 feet to 90 feet.

Large beams are lifted singly by placing the magnet poles in contact with the web, but smaller sections are lifted in pairs with the magnet spanning the adjoining flanges of the two beams.

THE WELLMAN SMITH OWEN ENGINEERING CORP. LTD.

PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1 WORKS : DARLASTON, South Staffs, & BELFAST

Photo courtesy Maas-Hansen Steel Co., Los Angeles, California

FOR EVERY APPLICATION, THERE'S ONE CRANE OUTSTANDING . . . P&H!

This low-cost, 10-ton floor-controlled P&H overhead crane is a production tool tailored to meet the multiple handling needs of this steel service center. Equipped with interchangeable coil and sheet steel grabs, as well as a hook scale, it warehouses the steel, services the shear, and loads shipments in a manner impossible to match with surface-bound equipment. Aisleways are reduced to an absolute minimum; valuable floor space is made to pay for itself.

Before you draw up your next crane specification, get the help of your local P&H man. He's backed by the largest group of engineers in the crane industry . . . and 76 years of experience in crane building. Then send your next crane inquiry where *most* smart buyers do — to Harnischfeger, world's largest builder of overhead cranes!

This P&H floor control station for overhead cranes puts easy pushbutton load handling under the operator's thumb. Depending upon service and load requirements, P&H floor-controlled cranes offer you a choice of single-, two-, or variable-speed control. Where needed, a skeleton cab can also be provided for overhead operation, and the pendant lowered to floor for intermittent use.

HARNISCHFEGER
Milwaukee 46, Wisconsin

P&H
OVERHEAD CRANES

Offices in major cities... see Yellow Pages

ENGINE BLOCKS:

HOIST 'EM FAST, HANDLE 'EM SAFELY!

These P&H Zip-Lifts play a vital role in the production setup for this modern automobile engine plant. They keep the ever-hungry transfer machines fed with a steady flow of engine blocks. In this production area, for example, P&H Zip-Lifts make up to 100 or more lifts an hour . . . throughout the day, day-in, day-out!

These heavy castings must be handled both quickly and safely. That's why P&H Zip-Lifts are on the job — they are the safest hoists in their class, and (like the name says) they've got plenty of *zip.*

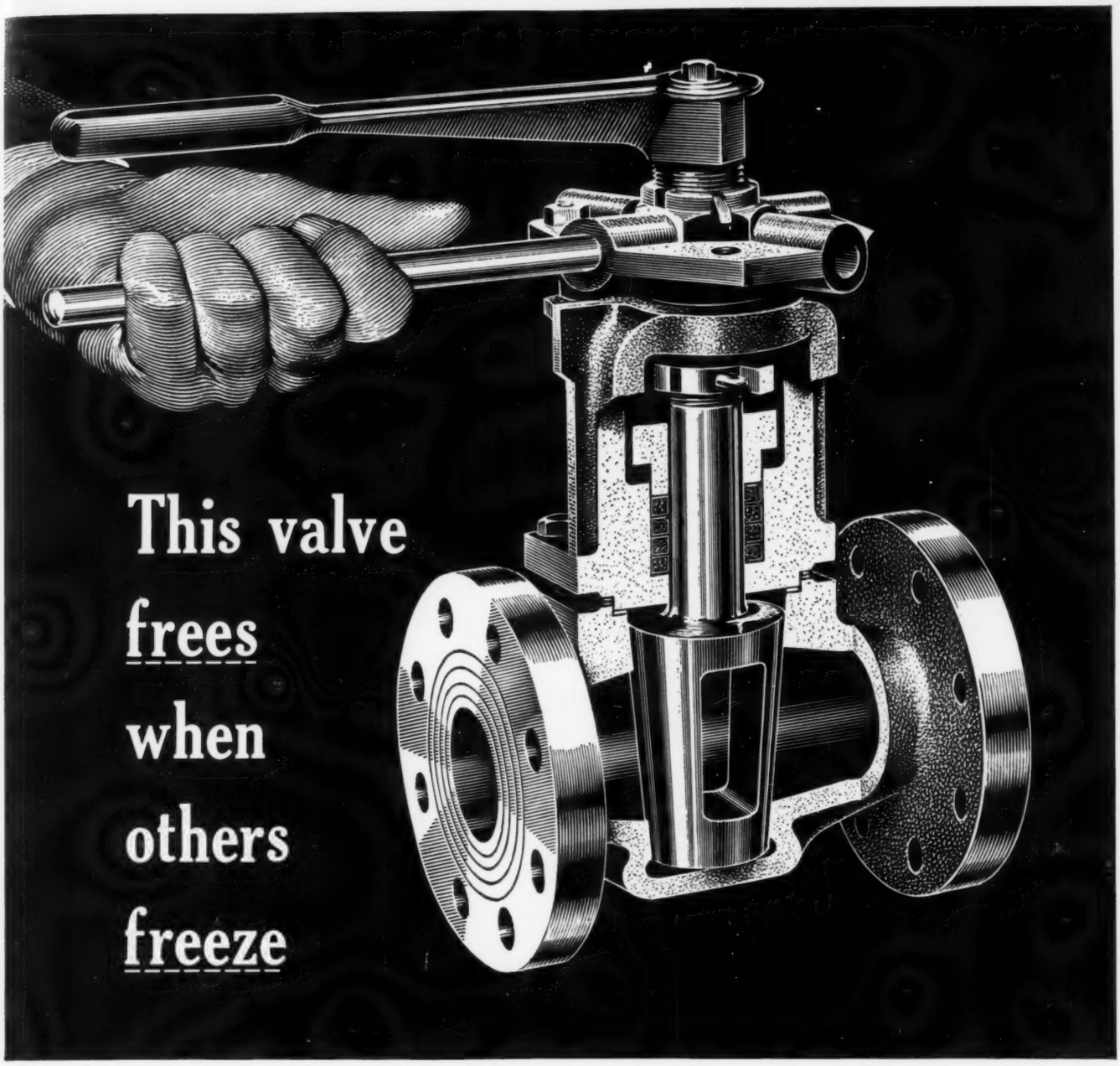
Isn't worry-free dependability and fast handling like this just as important in your operation? Find out more about the quality design features of P&H hoists. Surprisingly, real quality like this is priced unusually low, starting around $200. Call your nearest P&H Distributor — or write for Zip-Lift Bulletin H-20, Department 230, Harnischfeger Corporation, Milwaukee 46, Wisconsin.

HARNISCHFEGER
Milwaukee 46, Wisconsin

P&H
ELECTRIC HOISTS

See your Yellow Pages under "Hoists"

Photo courtesy Chrysler Corporation, Detroit, Michigan.



HOMESTEAD® LEVER-SEALD VALVE

It opens and shuts instantly, easily—when ordinary valves stick fast. Why? Because the Homestead Lever-Seald Valve has a positive built-in means of relieving friction and freeing the plug. Use it on lines requiring infrequent operation. Use it on lines handling slurries, viscous, caustic or corrosive fluids. Use it on lines carrying high-temperature or high-pressure fluids. Use it on lines where a lubricant is undesirable. Wherever you use it, the seats are protected from both corrosion and erosion in both open and shut positions. Under every service condition, you have positive control of the sealing or seating action for sure shutoff.

Over thirty years of demanding use prove that every Homestead Lever-Seald Valve gives long, low-cost, stick-proof control right down the line, with just a quarter of a turn. Complete facts in reference book 39-3, write for your free copy.

hv

HOMESTEAD VALVE MANUFACTURING COMPANY
"Serving since 1892"
P. O. Box 160, Coraopolis, Pennsylvania

Makers of: Homestead® Ball Valves, Cam-Seald, Lever-Seald and Lubricated Plug Valves

Down go back-up roll costs with

ith (USS) Quality Forged Sleeves

Pictured above is James S. Rennick, a metallurgist with twenty years' experience in the Forgings Division of U. S. Steel. Jim specifies composition, heat treatment, and other processing procedures essential to the production of assemblies as shown in the main picture—a back-up roll that will be used in the cold reduction tin mill at U. S. Steel's Gary, Indiana, plant.

This job points up a curious situation: U. S. Steel is one of the country's leading manufacturers of rolls, and also one of the biggest *users* of rolls . . . a double reason to perfect their performance and reduce their cost . . . just as we did here.

We had to replace a worn, cast steel back-up roll. Rather than replace the entire roll, we machined the face of the roll and shrunk on a *forged* steel sleeve. For back-up rolls like this one, 42" O.D. and larger, this method of sleeving is much less expensive than buying a complete new roll. One arbor can be used for several forged sleeves. A forged sleeve has a hard, wear-resistant surface and is highly resistant to spalling.

Also, the sleeve is purposely produced with a softer bore to develop a desirable stress pattern, and to provide maximum gripping between the arbor and sleeve after assembly.

There is a good possibility that we can help reduce *your* roll costs. Write or call the United States Steel Office nearest you, or United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

United States Steel Corporation, Pittsburgh • Columbia-Geneva Steel, San Francisco • Tennessee Coal & Iron, Fairfield, Alabama • United States Steel Export Company

United States Steel

USS

TRADEMARK

NO PLACE TO GAMBLE...

TAPECOAT®
is Your Best Bet
to Protect Mill Lines
in Underground Service

Joints on this water line at steel plant are TAPECOATED to provide protection equivalent to coating on the pipe.

You take no chances when you specify TAPECOAT coal tar coating in handy tape form for pipe, pipe joints, fittings, couplings, tanks, tie rods and conduit on new construction, as illustrated, or for preventive maintenance on replacements.

Since 1941, TAPECOAT has proved its superiority in resisting moisture, acids, alkalis, chemical fumes and other severe corrosive and abrasive conditions.

For example, failure of a water line at an eastern steel plant in 1946 prompted this producer to turn to TAPECOAT for protecting the new line. Results were so conclusive that they have since standardized on TAPECOAT for wrapping fire prevention, water, gas and fuel lines in sizes ranging from 2″ to 48″.

TAPECOAT comes in rolls of 2″, 3″, 4″, 6″, 18″ and 24″ widths. It is easy to apply with the use of a torch. No skilled help required.

A TAPECOAT sales and service engineer is always available to help you on any corrosion problem. Write for details today.

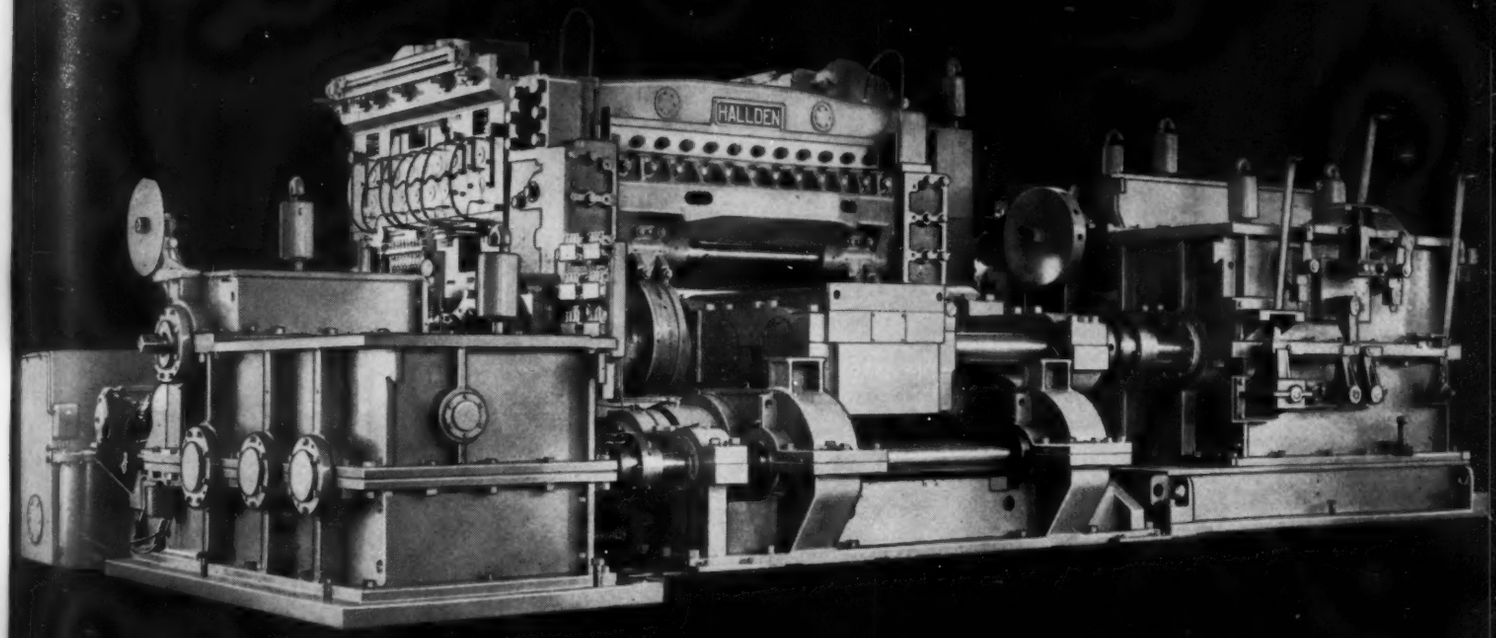
The TAPECOAT® *Company*

ORIGINATORS OF COAL TAR COATING IN TAPE FORM

1541 Lyons Street, Evanston, Illinois

Representatives in Principal Cities

Manufactured and distributed in Canada by The Tapecoat Company of Canada, Ltd., 25 Haas Road, Rexdale, Ontario



SYNCHRONIZED
GUILLOTINE FLYING SHEARS

Specified throughout the world for the most modern high speed processing lines

Hallden Flying Shears are built in a wide range of designs and sizes to meet any strip shearing requirement from tin plate to 5/8" plate. Length of cut ranges from 12 inches up to 48 feet. Synchronization adjustment "on the fly" available. These rugged units have been proven on steel, aluminum and brass strip in cut-up, galvanizing and special process lines for nearly 40 years. For all high production strip shearing consult Hallden, The Shearing Specialists.

HALLDEN

The world's leading machinery manufacturers rely on Hallden shears in their process lines

THE HALLDEN MACHINE COMPANY • THOMASTON, CONNECTICUT

Associates: The W. H. A. Robertson & Co., Ltd., Bedford, England

HOT STRIP MILL

Designed and Built by MESTA

FIRST with fully automatic controlled roughing mill

MESTA 44" Hot Strip Mill installation . . . including Vertical Edging Mill, Universal Reversing Roughing Mill, and six Finishing Mill Stands with three Finishing Vertical Edging Mills . . . at the Aliquippa Works of Jones & Laughlin Steel Corporation.

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

Personnel News...

Francis M. Rich has been appointed vice president in charge of planning, Wheeling Steel Corp. Mr. Rich was formerly vice president in charge of steel manufacturing at Inland Steel Co. Prior to that, he was vice president in charge of operations at Kaiser Steel Corp. His earlier experience was with The Steel Company of Canada, Ltd. and Republic Steel Corp.

Robert H. Henke has been appointed manager of Republic Steel Corp.'s Central Alloy Steel District, succeeding **Oscar A. Bamberger,** who has retired. Mr. Henke has been with Republic since January, 1959, during which time he has served as assistant manager of the Central Alloy Steel District. Prior to joining Republic, he had been manager of quality control at Allegheny Ludlum Steel Corp.'s Brackenridge, Pa., works. A veteran of 43 years in the steel industry, Mr. Bamberger began his career with Central Steel Co. (a Republic predecessor company in Massillon) in 1918. He was promoted into the plant's Metallurgical Department in 1921. In 1926 he was named supervisor of special metallurgical experiments for maintenance, and general foreman of the forge shop at Canton. In 1941, he was named superintendent of mechanical maintenance at Massillon, and three years later, was appointed superintendent of the Massillon steel operations. He became assistant manager of the Central Alloy Steel District in 1952, and district manager in 1953.

Roy P. Tooke has retired as manager of the Butler, Pa., plant of Armco Steel Corp. **Robert P. Hindman** will succeed Mr. Tooke as manager, and **William R. Gealey** will take Mr. Hindman's former position as general superintendent. Mr. Tooke joined Armco in 1922. He became chief engineer of the Ashland, Ky., works in 1931, and chief engineer of the Butler works in 1934. From 1942 to 1945 he served on special assignment in Mexico with Armco International Corp. He was made general superintendent of the Butler works in 1945 and manager in 1951. Mr. Hindman joined Armco in 1933. He was appointed assistant works metallurgist at Butler in 1939 and works metallurgist in 1949. He became assistant general superintendent in 1957 and general superintendent the following year. Mr. Gealey started at the Butler plant in 1933. He was named a foreman in 1938, an assistant superintendent in 1946, and a superintendent in 1956. He became assistant general superintendent of the Butler works in 1957.

Dr. William H. Ceckler has joined The Youngstown Sheet and Tube Co.'s Research and Development Department as supervisor of applied mathematics and operations research. Dr. Ceckler was previously with Jones & Laughlin Steel Corp., where he had been associated with the application of computers to blast furnace operations and to continuous annealing and finishing of tin mill products.

Daniel A. Porco and **Eugene A. March** have been elected vice presidents with Crucible Steel Co. of America. Mr. Porco was formerly assistant to the president and Mr. March, who becomes vice president of technology, was formerly director of technology.

Walter F. Schneid has retired as vice president and general manager of Eastern Stainless Steel Corp. He will continue as a member of the board of directors and will also be retained in an advisory capacity. Mr. Schneid started his career in the steel industry over fifty years ago in Syracuse N. Y. He joined Eastern in 1946 as vice president in charge of operations.

Robert M. Boyer has been named superintendent of the Mechanical Department of Bethlehem Steel Co.'s Lackawanna, N. Y., plant. Mr. Boyer succeeds **James O. Dague,** who was recently made an assistant general manager of Bethlehem's Steelton, Pa., plant. **David A. Barker** succeeds Mr. Boyer as assistant superintendent. Mr. Boyer joined Bethlehem in 1937 as a member of its loop training course, and was assigned to the Mills Division at Lackawanna. He was appointed mechanical foreman of the 54-48 in. mills in 1939 and

F. M. RICH

R. H. HENKE

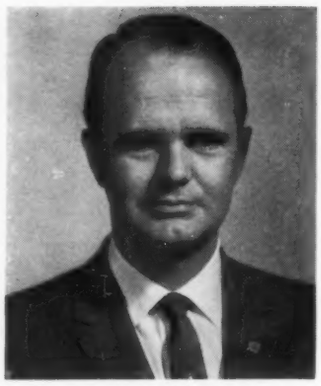
R. P. HINDMAN

W. R. GEALEY

J. R. PURDY

MELVIN SUMRALL

J. P. WILLIAMS



R. L. DURGIN

became a master mechanic in 1940. He was made assistant superintendent in 1951. Mr. Barker also began with the loop course and has been attached to the Mechanical Department since 1950, when he was promoted to assistant general foreman. He became master mechanic of the department in 1957.

John R. Purdy has been appointed superintendent of The Colorado Fuel and Iron Corp.'s Pueblo coke plant. Mr. Purdy has been serving as assistant of the coke plant since May, 1960. Previously he was practice man, plant turn foreman and efficiency engineer, having joined CF&I in 1927 as instrument man in the Efficiency Department of the coke plant. **Walter E. Burns** was named assistant superintendent of the coke plant. Mr. Burns has been serving as general foreman of the coke plant since May, 1960. Previously he worked as plant turn foreman, turn foreman, engineer, and saturator man in the By-Products Department, having joined CF&I in 1917 as an employee in the Coke Plant Department.

Melvin Sumrall has been appointed assistant superintendent of The Colorado Fuel and Iron Corp.'s Pueblo plant seamless tube mill. Mr. Sumrall has served as general foreman of the hot mill since 1955. Prior to this he worked as hot mill turn foreman in the seamless tube mill and as metallurgist. He joined CF&I's Pueblo plant Metallurgical Department as a laboratory technician.

James P. Williams has been named manager, consulting services for Arthur G. McKee & Co. Prior to joining McKee, Mr. Williams was associated since 1945 with Kaiser Steel Corp., where he had been chief industrial engineer and, for the past 10 years, manager of engineering and planning. Before that he was with United States Steel Corp. for a number of years as an industrial engineer.

R. L. Durgin has been appointed vice president of Illinois Gear & Machine Co. Mr. Durgin joined the company in 1955.

Jack H. Cobb has been appointed Chicago sales representative of Victor R. Browning & Co., Inc.

Joseph M. Duncan has been appointed manager of the North Central region by Allis-Chambers Manufacuring Co.'s Industries Group. He succeeds **C. F. O'Riordan,** recently named general manager of the company's Defense Products Division. Mr. Duncan had been assistant general manager of the company's Washington, D. C., office since May, 1960. He joined the company in 1949 and was a sales representative in the Atlanta and New Orleans districts before becoming manager of the Atlanta district in 1956.

Walter A. Mosteller, a pioneer in application engineering and until recently an executive of the General Electric Co., has retired after 38 years of service. Mr. Mosteller joined General Electric in 1923, enrolling in the company's test program. He entered direct current engineering and, in 1927, joined industrial engineering. In 1929, he was assigned to the Chicago office as an apparatus field engineer. Two years later, he became an application engineer and joined the Detroit office. In 1949, Mr. Mosteller was appointed product sales manager for the Michigan district, and district sales manager in 1953. He was appointed manager of General Electric's User Sales Department in 1959, with responsibility for a large segment of the company's apparatus business.

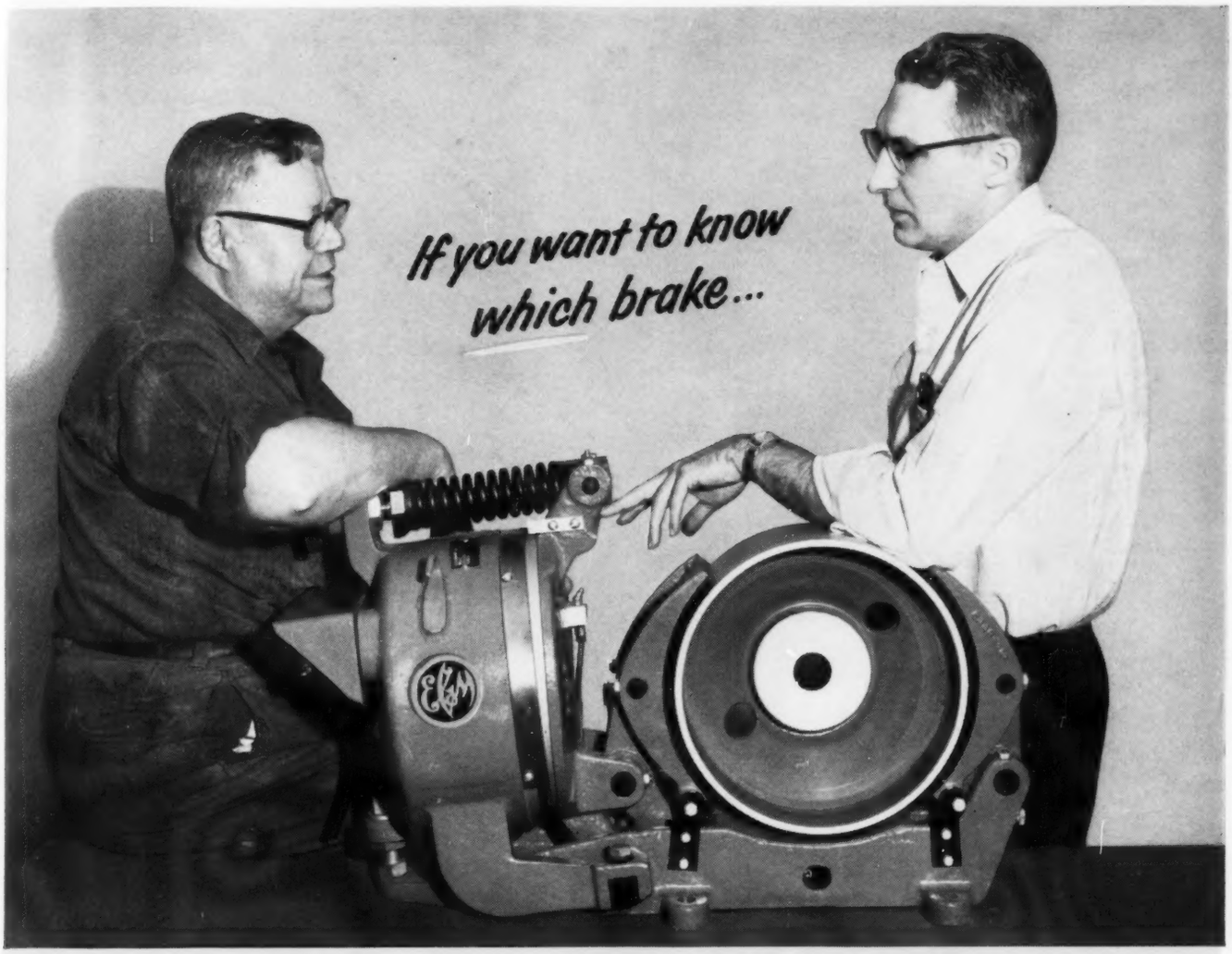
Wilford E. Metzger, Jr., was named assistant sales manager, Hydraulic Machinery Div., Birdsboro Corp. Mr. Metzger was previously associated with E. W. Bliss Co. for 12 years as assistant chief engineer and New England district sales manager.

Sherwood J. Basch has been named vice president of engineering of the Morton Manufacturing Co. Mr. Basch has been with the company in various engineering capacities since 1940.

Bertram S. Parker was elected president of The Youngstown Foundry & Machine Co. He succeeds **B. G. Parker,** who was elected chairman of the board.

S. J. BASCH

B. S. PARKER



Ask the Maintenance Men!

There are certain standards of performance maintenance men expect of any brake used on crane or mill applications. EC&M's WB Brakes, they'll tell you, have surpassed those standards for years—with plenty to spare.

It's when you ask about installation and maintenance that you'll find why so many of these men prefer Type WB Brakes.

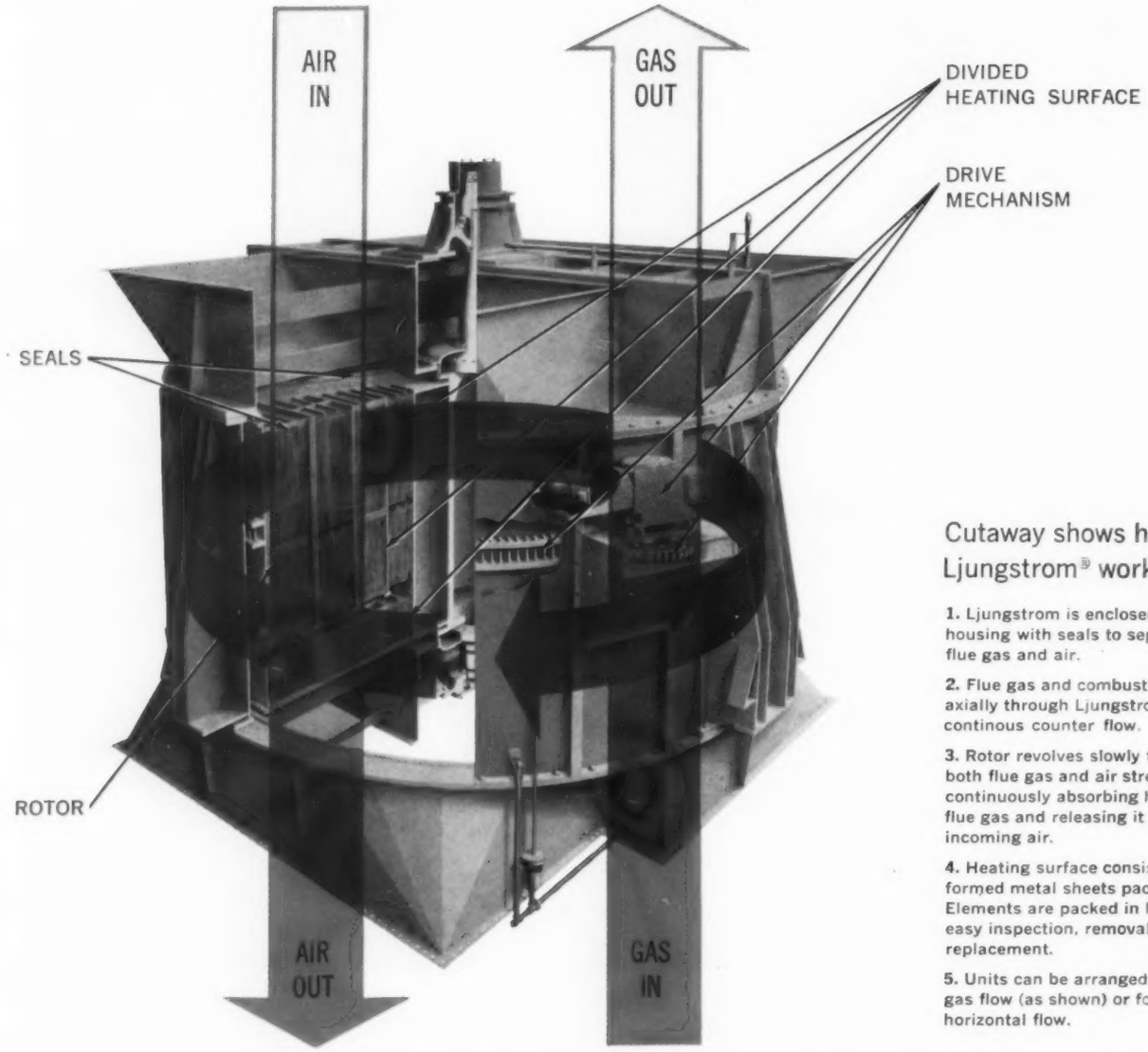
Without getting into a lot of detail, here are a few features of WB Brakes which the maintenance men rate very high—

Manual release for free rotation—a real convenience when you're setting up a new installation. Or want to lower a load on power failure. Or when you're replacing a shoe or lining. ***Single adjustment for lining wear***—so simple yet so positive. ***Connecting lever <u>below</u> brake wheel***—really speeds up armature replacement. ***Recessed armature*** lets dust and magnetic particles fall free—no periodic "digging out". ***No freeze or bind***—if lubrication is ever needed to free any part, WB Brakes have alemite fittings at all points.

***SIX SIZES** of WB Brakes cover the complete range of 600-series motors*
Write for the New Bulletin 5000—it tells all

SQUARE D COMPANY
EC&M DIVISION • CLEVELAND 28, OHIO
wherever electricity is distributed and controlled

2637



Cutaway shows how Ljungstrom® works

1. Ljungstrom is enclosed in gas tight housing with seals to separate flue gas and air.

2. Flue gas and combustion air pass axially through Ljungstrom in continous counter flow.

3. Rotor revolves slowly through both flue gas and air stream, continuously absorbing heat from flue gas and releasing it to incoming air.

4. Heating surface consists of many formed metal sheets packed in rotor. Elements are packed in baskets for easy inspection, removal or replacement.

5. Units can be arranged for vertical gas flow (as shown) or for horizontal flow.

HERE IS A WAY TO RECOVER AS MUCH AS 1000°F FROM FLUE GAS

. . . and cut your fuel costs 1% for each 35°-40°F recovered!

More complete combustion . . . higher furnace temperatures . . . increased furnace capacity . . . improved product – these are established advantages of preheating combustion air. And the Ljungstrom® Air Preheater, *on the basis of fuel savings alone*, deserves careful investigation. For it is *the* most efficient metallic heat exchanger ever developed. It can recover as much as 1000°F from flue gas, with savings in fuel costs of 1% for each 35°-40°F recovered.

High efficiency in extremely small space

The Ljungstrom rotor revolves continuously through the flue gas and incoming air . . . absorbs heat and releases it from *the same surface*. Since heat does not have to pass *through* the heat exchange surface, the Ljungstrom is remarkably efficient and compact. A unit measuring 5′ x 7′ x 8′, using 2000°F flue gas diluted to 1500°F, can handle a furnace exhausting 30,000,000 Btu/hr and raise incoming air from 70°F to 1400°F.

Applications in the steel industry

Ljungstroms can perform efficiently in many steel-making applications: reheat furnaces, soaking pits, slab, billet and skelp furnaces. Used in series with checkers they can provide far higher and more uniform preheating than any other heat exchangers now in use.

Tested and proved under all conditions

Ljungstrom's continuous rotary regenerative principle has been performance-proved for more than 35 years in over 3500 units. The electric utility industry (highly conscious of fuel costs) has virtually standardized on Ljungstroms. *Every* major U.S. utility is Ljungstrom equipped, with some units in continuous service since 1923. Refineries, chemical process plants – even ocean liners and cargo vessels – save fuel with Ljungstroms. For more information on how Ljungstroms can benefit you, write:

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N.Y.

Bertram S. Parker joined the company in 1922. In 1931 he was appointed foundry superintendent and in 1942 was elected vice president and director. He has also been general manager since 1954. A vice president to succeed him will be elected by the directors later. The new chairman of the board, B. G. Parker, served as president since 1930.

Howard Van Meter has been named superintendent of blast furnaces at The Youngstown Sheet and Tube Co.'s Brier Hill plant. He succeeds **Furman T. Blackwell** who has retired after 41 years with the company. Mr. Van Meter joined the company in 1936 as a laborer in the Campbell Blast Furnace Department. Later he became stock house foreman at the company's Hubbard furnace. In 1938 he returned to Campbell as a gas operator and then a blower, was named turn foreman and since 1959 has served as assistant superintendent of the Brier Hill blast Furnace Department.

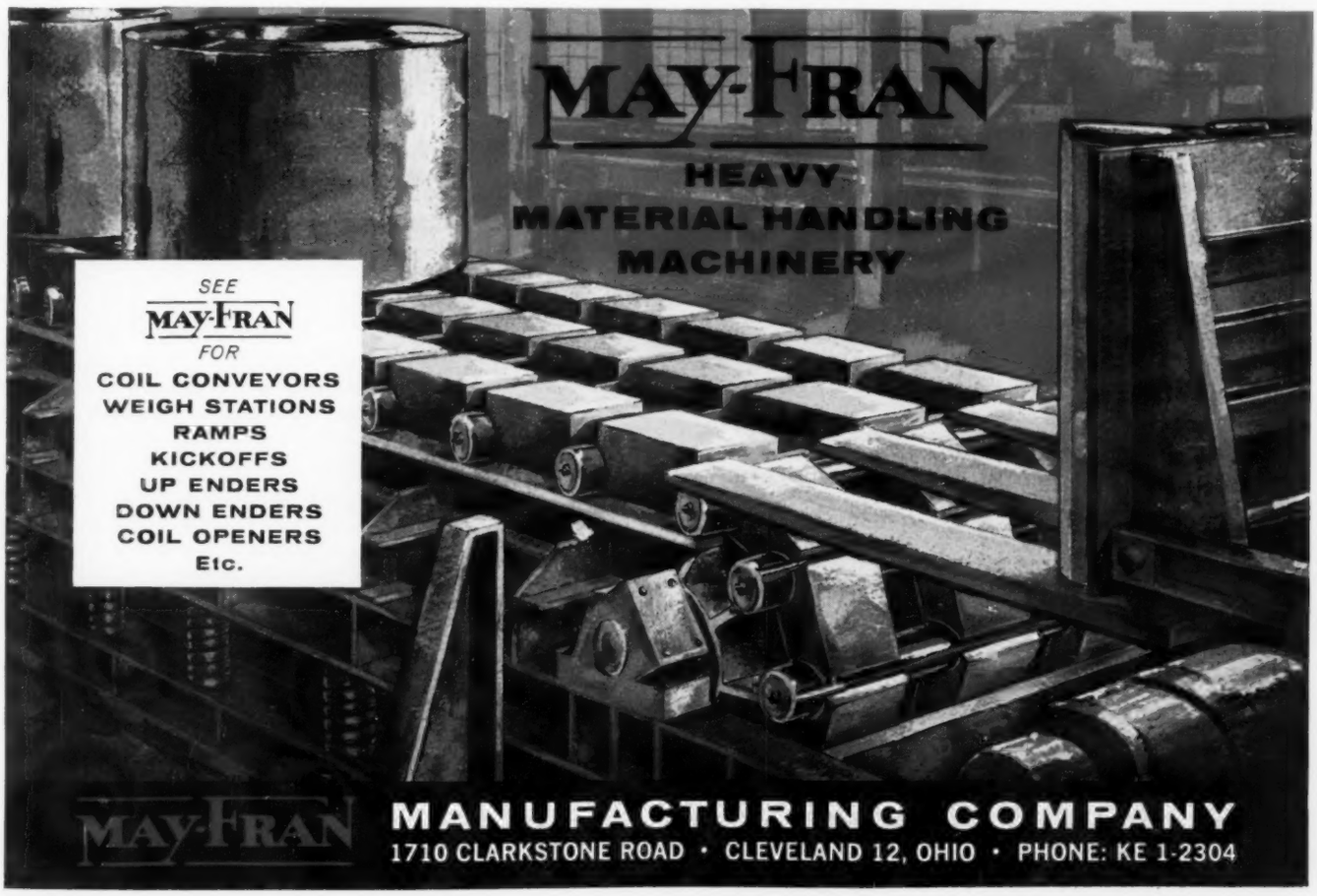
William R. Heck has been appointed manager of mechanical equipment sales, Sutton Engineering Co. He joined Sutton as a sales engineer in 1956. **R. A. Bland** continues as general sales manager of both mechanical and hydraulic equipment.

Patrick A. Travisano has been named manager of a newly-formed heavy mill engineering subsection at General Electric Co.'s Industry Control Department. The new organization will replace the portion of the department's former equipment engineering subsection devoted to application, systems and design engineering services for the steel and other basic metal industries. Mr. Travisano joined the company in 1946 at Philadelphia, serving for a year on test program assignments, and has been associated with the Industry Control Department since 1947. A specialist in heavy mill engineering during his entire career with the department, Mr. Travisano has been unit manager of heavy mill systems engineering since 1955 until named to his present post.

H. E. Johnson has been appointed to the position of district manager of the Cutler-Hammer, Inc., Buffalo sales office. He joined the company's Engineering Department in 1948. Later he transferred to the firm's headquarter Sales Department and in 1949 he became a member of the Cleveland sales office, the position he held at the time of his most recent appointment.

J. W. McClurkin has been named assistant superintendent of the Open Hearth Department at Republic Steel Corp.'s Warren, Ohio, plant. He succeeds **P. J. Bartholomew,** who retired recently. Mr. McClurkin joined Republic in 1947. He started in the Combustion Engineering Department and the following year became a technical operating trainee. He was made a foreman in the open hearth stock house in 1950 and in 1958 was appointed general foreman in the Open Hearth Department, the position he held until taking over his new duties.

John E. Meyers has been appointed manager of the Coupling Department, Koppers Co., Inc. He has been marketing manager of the company's Sound Control Department. Mr. Meyers joined Koppers in 1941 as



L. N. COLLINS

V. B. JENSEN

J. W. HAMMARBERG

J. P. McCLOSKEY

junior engineer. From 1949 to 1960, he was district sales manager of the Pittsburgh district before returning to Baltimore to accept the marketing position.

Lawrence N. Collins was named assistant sales manager of Arthur G. McKee & Co.'s Metals Division. In this newly-created position, Mr. Collins will be responsible for developing sales of coke ovens of the Firma Carl Still design in the United States, Canada and Mexico. Mr. Collins joined McKee in 1956 as manager of the firm's Consulting Department. Prior to that he was for six years assistant general superintendent of the Tata Iron and Steel Co. Mr. Collins began his business career with Republic Steel Corp.'s Blast Furnace and Coke Oven Departments in the firm's Youngstown, Ohio, district. After 14 years of service in various capacities with Republic, he became associated with the Wilputte Coke Oven Division of Allied Chemical and Dye Corp., where he remained for several years before joining Tata.

Vernon B. Jensen has been appointed district manager for the Cleveland Tramrail and Steelweld Machinery Divisions of The Cleveland Crane & Engineering Co. in the Cleveland, Toledo and Detroit areas. Mr. Jensen previously was with the Cleveland Tramrail distributor organization in San Francisco, Calif., as sales and project engineer.

John W. Hammarberg has been appointed manager of the Chicago sales office of Heppenstall Co. and Midvale-Heppenstall Co. Mr. Hammarberg has served since 1956 as a district representative in the Detroit sales office.

John P. McCloskey was named to a new post of manager of sales for the Pittsburgh office of The Rust Engineering Co. He has been a sales representative since joining Rust four years ago.

Samuel F. Smith and **Howard V. Seifert** have been named service chief and assistant service chief, respectively, at Republic Steel Corp.'s Union Drawn Steel Division plant in Beaver Falls, Pa. Mr. Smith has been with Union Drawn in Beaver Falls since 1943. He was appointed assistant service chief four years later and was named acting service chief in April of this year. Mr. Seifert started with Union Drawn at the Massillon, Ohio, plant in 1941, and was transferred to the Beaver Falls plant in 1954. He was appointed assistant chief clerk in April of this year.

John W. Anderson has been named vice president of engineering of Minneapolis-Honeywell Regulator Co.'s Electronic Data Processing Division. Mr. Anderson, formerly manager of Honeywell's inertial guidance plant at St. Petersburg, Fla., succeeds **J. Ernest Smith,** who has been named vice president of the EDP division.

Carleton C. (Jeff) Davis, Jr., was appointed manager of the Compressor Sales Department, Elliott Co. Mr. Davis joined Elliott in 1943 as a member of the Compressor Engineering Department. He became a member of Carrier Corp.'s Compressor Engineering Department in 1951, moving into sales in the Cleveland district in 1952. With the merger of Carrier and Elliott, he became a compressor specialist for the Central region, handling sales of both lines of compressors.

Obituary

Charles P. Betz died recently at the age of 72. Mr. Betz retired in 1954 as plant superintendent of the Blast Furnace Division and coke plant, Great Lakes Steel Corp. He joined Great Lakes in 1937, and had previously worked at The Youngstown Sheet Tube Co., and at Republic Steel Corp.

William B. Kennedy, vice president—Civil Engineering Department of Auburn & Associates, Inc., died recently. He was 38. He came to Auburn in 1955 from Salem-Brosius, Inc.

George M. Ullom, Birmingham, Ala., district sales manager for Harbison-Walker Refractories Co., died May 13. He was 55. Mr. Ullom began his career with Harbison-Walker in 1929 at Pittsburgh, and also served in various capacities in Portsmouth, Ohio, and Kansas City, Mo. He had been the Birmingham district sales manager since 1953.

Paul E. Thomas, assistant chief engineer of the steel and coal sections of United States Steel Corp., died recently. He formerly served as assistant division superintendent of maintenance, plant chief engineer and assistant general superintendent of Gary works.

Don N. Watkins, board chairman of Steel Publications, Inc., died June 16. Mr. Watkins had a long association with the steel industry, serving as assistant superintendent, blooming mill, at Jones & Laughlin Steel Corp., president of Laclede Firebrick Co. and as vice president of Continental Foundry and Machine Co.

Stamco has a new, compact and streamlined design... Rated 3 cuts of 3/16" mild steel.

Important advances in design and material make this unit the finest at the lowest possible cost.

Stamco is proud to announce the "All Purpose" Slitting and Coiling line. Years of engineering study have resulted in the development of this outstanding slitting equipment. These years of research are reflected in unusual features of this line.

Stamco, Inc.,
New Bremen, Ohio, U.S.A.

DISTRICT OFFICES
STAMCO SALES, INC.

R. P. Popp
18450 Livernois
Detroit 21, Michigan

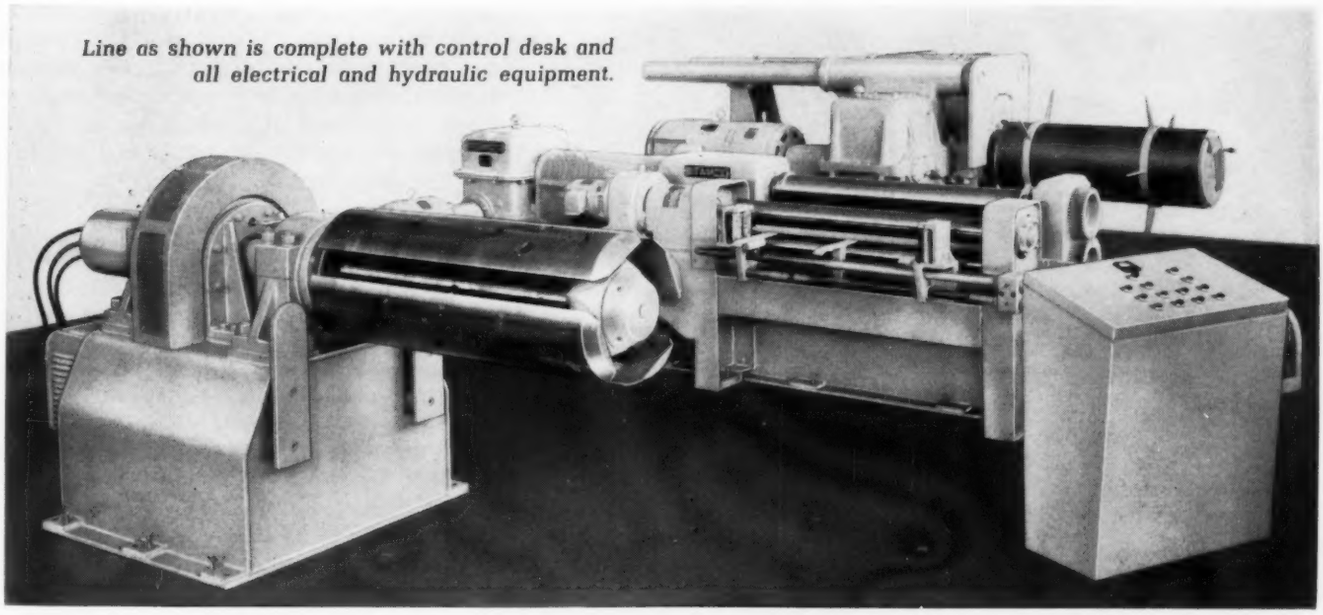
R. P. Popp
101 Investment Bldg.
Pittsburgh 22, Pa.

I. W. Spraitzar
159 Main Street
Chatham, New Jersey

W. E. Heineman
122 West Burlington Ave.
LaGrange, Illinois

W. H. Millan
11955 Shaker Boulevard
Cleveland 20, Ohio

Line as shown is complete with control desk and all electrical and hydraulic equipment.



Slitting and Coiling Lines • Cut-to-Length Lines • Flying Shear Lines • Power Squaring Shears • Continuous Process Lines • Ferrous & Non-ferrous Mill Equipment

Replace old-fashioned couplings with Rockwell-Standard's

BLOOD BROTHERS

HEAVY-DUTY INDUSTRIAL DRIVE LINES

ROCKWELL-STANDARD ENGINEERS specifically designed Blood Brothers Heavy-Duty Industrial Drive Lines to replace couplings in industrial applications. They improve machine performance and efficiency...last longer... give better service than any coupling. They often reduce costs by eliminating the need for bearings and supports required by conventional coupling installations. Wearing parts are quickly replaced and even drive lines can be replaced in 15 minutes!

Available in capacities up to 500,000 torque inch pounds, they are adaptable to a variety of applications—rolling mills, oil field equipment, irrigation pumps, cargo carriers, marine drives, logging winches, mining machinery and many others.

Blood Brothers Industrial Drive Lines offer these special features:

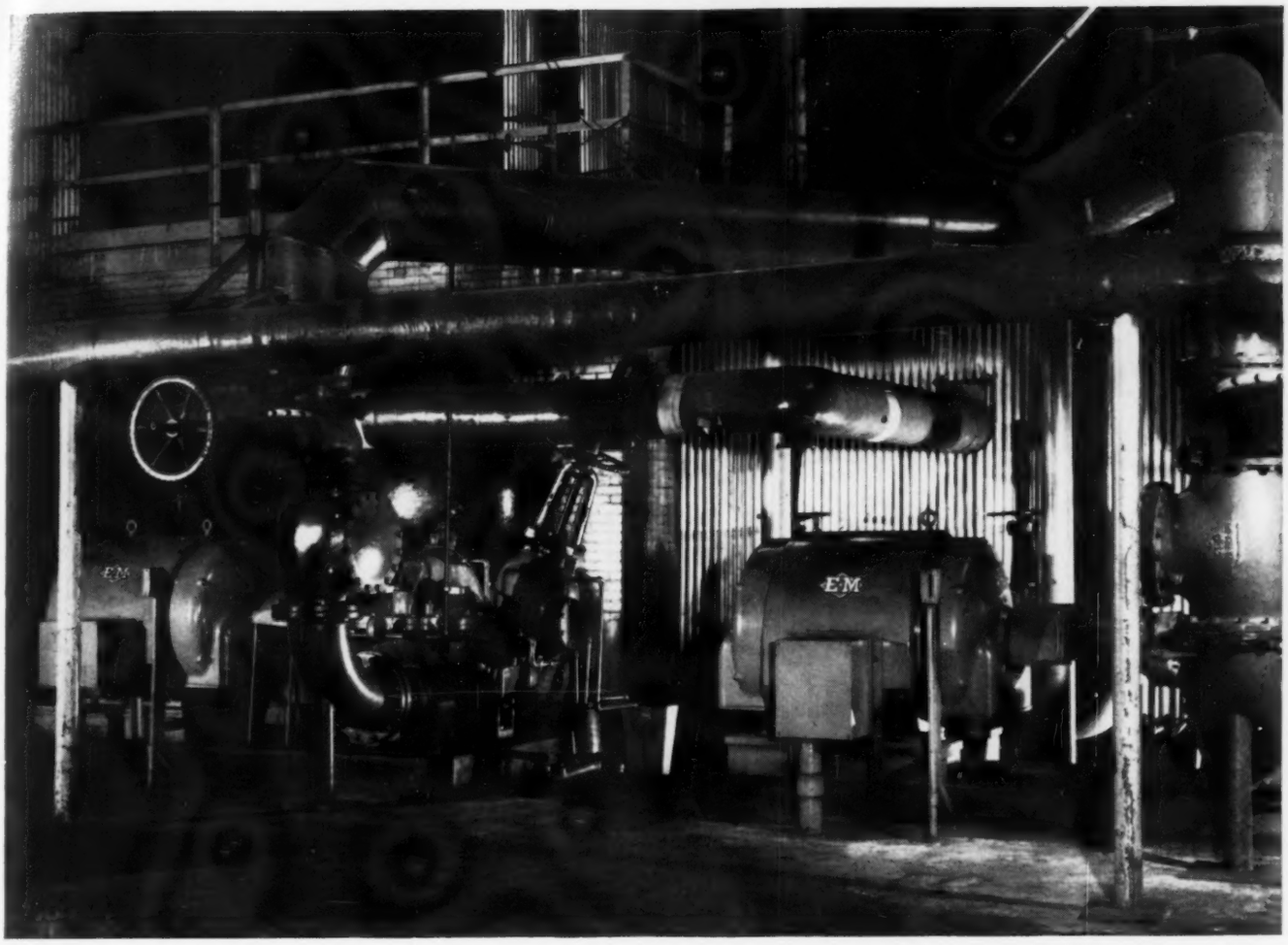
• Wing bushings that eliminate costly flange yokes and reduce down time during servicing. Simply remove 8 bolts for complete disassembly • Sliding spline provides for quick, easy assembly—variations in mounting locations—longitudinal shaft movements during operation—deflections and temperature changes • Easy access to lubrication fittings.

Another Product of...

ROCKWELL-STANDARD CORPORATION

ROCKWELL R STANDARD ®

Universal Joint Division, Allegan, Michigan



Jones & Laughlin Steel Corporation enjoys low maintenance costs on large motor drives

● Safeguarding motor operation in a steel mill is an important factor in the mill's over-all profitable operation. Motor shut down means costly maintenance projects and large production losses. Bearing failures and winding burn outs are no longer considered inevitable, and today's mill operators who are interested in continuous high-level production are taking advantage of modern motor design to insure against motor failure.

The two 400 hp, 1450 rpm, splash-proof E-M Squirrel-Cage Induction Motors above show how Jones & Laughlin Steel Corporation engineers use modern motor design to protect against motor outage. These motors, which drive centrifugal pumps supplying water to three hot strip-mill furnaces at the Pittsburgh works, have given year-in, year-out service with only routine bearing lubrication and inspection. E-M *Protective Construction* keeps water and foreign material out of vital parts, so essential to uninterrupted, trouble-free operation.

And remember, *Protective Construction* means more than physical shielding of windings and bearings with splash-proof or other protective enclosures. It includes the E-M "know-how" of motor design and special attention to the smallest details of construction. Here are some of the important features in E-M *Protective Construction:*

1. Windings custom designed for the application, repeatedly processed to keep moisture out.
2. Coil ends methodically lashed to heavy rings to prevent movement during repeated starting surges.
3. Bearings precision engineered and processed for cool, long-life service.
4. And rotors of practically indestructible cage construction, accurately balanced for vibration-free operation.

For your next special motor application call on your local E-M sales engineer for helpful counsel. Let him show you how E-M *Protective Construction* can help keep your maintenance costs low on large motor drives. And write the factory for E-M Synchronizer No. 53, showing other modern motor applications in modern steel mills.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

E-M

1300-TPA-2167A

Specialists in making motors do **EXACTLY WHAT YOU WANT THEM TO**

5000 psi; 1¼" -2"; 2, 3 and 4-way; 2 and 3-position; optional sub-plate mounting
5000 psi; ½" -2"; 2, 3 and 4-way; 2 and 3-position optional sub-plate mounting
5000 psi; 2" - 4"; 3 and 4-way; 3-position
2000 psi; ½" - 1"; 2, 3 and 4-way; 2 and 3-position

for water or oil service

HUNT *Hydraulic Valves*

zero leakage • shock-reducing operation • sizes from ½"- 8" • pressures to 5000 psi

If you're designing or operating hydraulic systems requiring valving of *raw* water, soluble oil and water, or oil, and if you're interested in precise control, positive shut-off, reduction of shock and hammer, plus years of trouble-free operation . . . you'll find it worthwhile to investigate Hunt's complete line of hydraulic valves, featuring *resilient U-packers*. The higher the pressure, the tighter the seal!

You'll have a choice of 3 pressure ranges, 2000, 3500 and 5000 psi . . . a choice of sizes from ½ through 8 inches . . . a choice of manual lever or remote pilot actuation . . . a choice of types — 2-way, 3 and 4-way, 2 or 3-position . . . a choice of steel or high tensile cast or forged brass bodies and direct or sub-plate mounting in many sizes. You'll even find double check types, capable of withstanding pressure in both directions without external check valves, ideal for hydrostatic testing of tubes, pressure vessels and similar items.

Take advantage of Hunt's years of experience in hydraulic control. Call in your Hunt representative for recommendations today.

For more information, write for Bulletin 604. Address Hunt Valve Company, Salem, Ohio, Dept. ISE-761

HUNT

QUICK-AS-WINK® AIR AND HYDRAULIC

VALVES

HUNT VALVE COMPANY • DIVISION OF IBEC • SALEM, OHIO

3016

AMSCO reversing table gears give 6 to 7 times longer life

Problem: Carburized steel gears on the reversing table of a 44″ blooming mill *failed* every 2-4 months. Mill production *stopped* during replacement.

Solution: Amsco manganese steel mitre gears installed.

Result: Service life increased to over 18 months. Gear tooth spalling and breaking stopped.

Unusual? Not at all. We have records taken from the files of most major steel mills that show identical or better results under equally brutal conditions.

Amsco manganese steel gears make good sense. Their initial cost is usually less than carburized gears *plus* a service life up to 7 times greater.

If you are interested in stopping frequent mechanical shutdowns due to gear failure, check with your nearest AMSCO representative. He can recommend cost-cutting, production-boosting solutions to your problems.

1461

AMSCO

AMERICAN MANGANESE STEEL DIVISION
CHICAGO HEIGHTS, ILLINOIS

AMERICAN Brake Shoe COMPANY

Other plants in:
Denver • Los Angeles • New Castle, Delaware
Oakland, California • St. Louis
IN CANADA: Joliette Steel and Manitoba Steel Foundry Divisions
IN MEXICO: Amsco Mexicana, S.A.

here's PROOF of 'S

PHOTOS AND STATEMENT FROM A

Photo above shows 3" steel bars, prior to descaling.

Photo of the same bars, after descaling with "SUPER-STEEL". Bars are thoroughly cleaned—have excellent surface finish —*without graphitic smear!*

f "SUPER-STEEL" performance!

SHOT OR GRIT

M A PROMINENT BAR MILL IN THE PITTSBURGH AREA

Please check the photos on the opposite page carefully. They are *unretouched* photos, taken in this well-known steel plant, of 3" bar stock "before" and "after" descaling with "SUPER-STEEL" shot in centrifugal blast cleaning equipment. A letter received from their Plant Engineer states that "SUPER-STEEL" has greatly improved the surface finish of their bars and substantially reduced their blast cleaning operation costs. The letter goes on to say that they are well pleased with the abrasive engineering service provided by METAL BLAST and, finally, that they highly recommend "SUPER-STEEL" for efficient and economical cleaning for steel mill operations.

If you're not entirely satisfied with the performance (or cost) of your present steel abrasives, why not try "SUPER-STEEL"? In addition to the excellent performance and service referred to above, you'll get greater "resistance to breakdown" and lower maintenance costs — yet you pay less for "SUPER-STEEL"! You can't help but cut cleaning costs — in fact, we'll guarantee it! Write, wire or phone collect — we'll rush a trial order, test sample, more information or have our abrasive engineer call.

"SUPER-STEEL" SHOT or GRIT

$165.00 PER TON TRUCK LOADS

Packed in 50 or 100 lb. bags, steel drums, pallets.

MANUFACTURED BY A NEW AND MORE ECONOMICAL PROCESS, DEVELOPED BY METAL BLAST, INC. PATENTS APPLIED FOR.

METAL BLAST, INC.

876 EAST 67th STREET • CLEVELAND 3, OHIO • Phone EXpress 1-4274

ALSO IN: Chattanooga • Chicago • Cincinnati • Dayton • Detroit • Elberton, Ga. • Grand Rapids • Greensboro, N. C. Houston • Los Angeles • Louisville • Milwaukee • Minneapolis • New York • Philadelphia • Pittsburgh and St. Louis.

MANUFACTURERS, ALSO, OF TOP QUALITY "SEMI-STEEL" SHOT AND GRIT, MALLEABLE AND CHILLED SHOT AND GRIT — AT COMPARABLE SAVINGS!

WHY STOCK DC CONTACTORS AND RELAYS?

. . . when you can assemble more than 100 devices from General Electric "building-block" components

There's no need to carry a large inventory of d-c contactors and relays . . . just to be sure you have the correct device when you want it!

"Building-block" design of General Electric contactors and relays permits you to assemble more than 100 different devices—right in your own plant—from a stock of as few as a dozen standard components.

G.E.'s "universal" contact block is the building unit for all types of contactors and relays. Choice of standard frame-and-coil assembly with proper combination of contact blocks and standard assembly kit permits the variation in devices to meet your specific application requirements.

Three complete contactor lines and six relay lines—for general-purpose, mill-duty, overload, and timing functions—can be assembled using this unique approach.

Rely on General Electric for all components—General Electric also has complete lines of plate rheostats and resistors. For additional information, contact your General Electric Sales Representative, or mail the coupon below. *Industry Control Department, Salem, Va.*

GENERAL ELECTRIC

Resistors—vitreous-enameled and wire- and ribbon-wound types from 5 to 1210 watts. Fixed, slide-wire, or tapped types available.

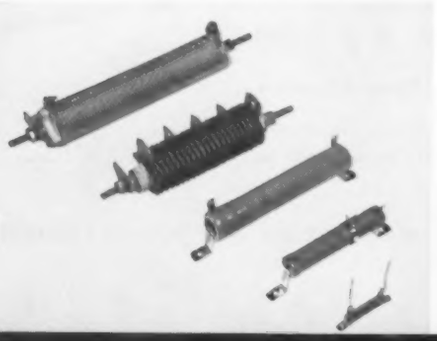


Plate-type rheostats—windings are completely encased in metal to give longer and more reliable service for any application.

To: Section D784-31
General Electric Co.
Schenectady 5, N. Y.

Please send the following bulletins:

- ☐ GEA-6621—D-c contactors and relays
- ☐ GEA-6592—Resistors
- ☐ GEA-6474—Plate-type field rheostats

Name_____

Company_____

Address_____

City_____

State_____

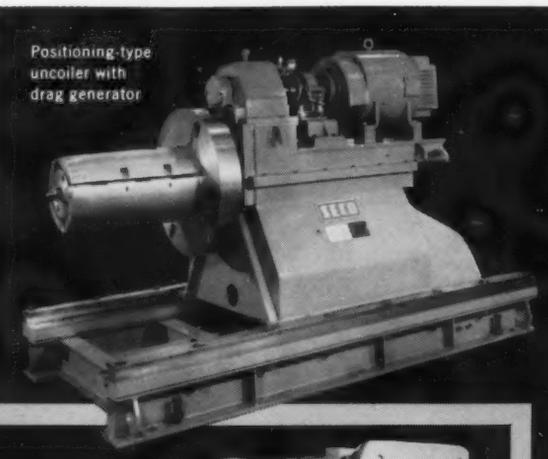
46 x 90-inch Universal Slabbing Mill.

BLAW-KNOX SLABBING-BLOOMING MILLS

Blaw-Knox designs and builds slabbing-blooming mills in a complete range of sizes in universal and high lift types. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations and auxiliary equipment for ferrous and non-ferrous metals. Sheet and strip processing equipment. • Electrolytic tinning, annealing, and galvanizing lines. • Seamless pipe and tube mills. • Draw benches, and cold draw equipment. • Blaw-Knox Medart cold finishing equipment. • Iron, alloy iron and steel rolls. • Carbon and alloy steel castings. • Fabricated steel plate or cast-weld design weldments. • Steel plant equipment. • Heat and corrosion resisting alloy castings. • Blaw-Knox Company, Foundry and Mill Machinery Division, Blaw-Knox Building, 300 Sixth Avenue, Pittsburgh 22, Pa.

BLAW-KNOX

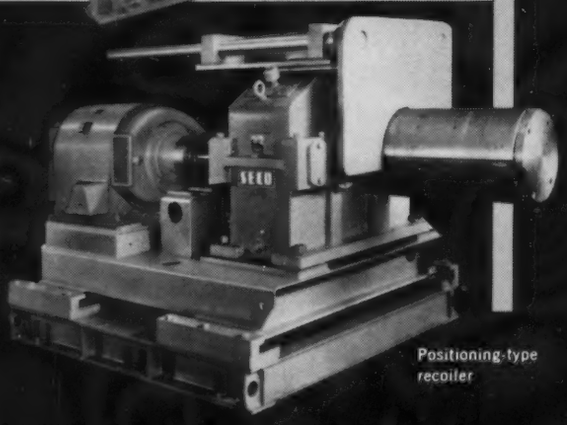
Blaw-Knox designs and manufactures for America's growth industries: METALS: Rolling Mills • Steel Processing Lines • Rolls • Castings • Open Hearth Specialties • PROCESSING: Process Design, Engineering and Plant Construction Services • Process Equipment and Pressure Piping • CONSTRUCTION: Concrete and Bituminous Paving Machines • Concrete Batching Plants and Forms • Gratings • AEROSPACE: Fixed and Steerable Antennas • Radio Telescopes • Towers and Special Structures • POWER: Power Plant Specialties and Valves



Predictable Performance

for processing lines with

SECO *terminal equipment*

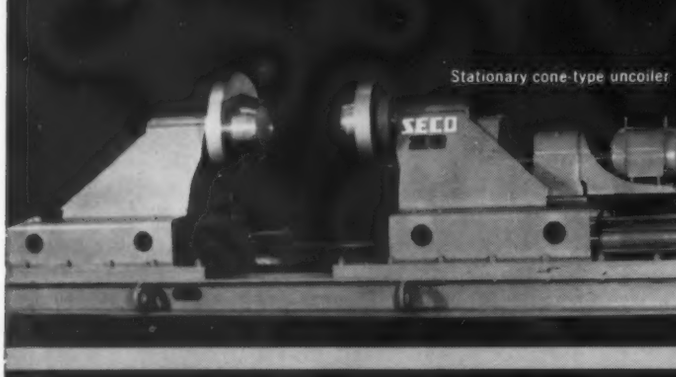


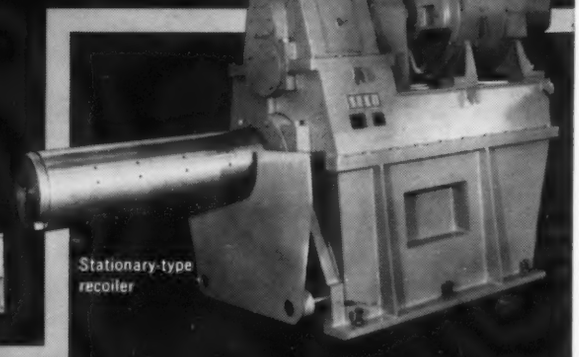
From entry to exit, new and modernized processing lines . . . annealing, pickling and others . . . perform better with SECO terminal equipment. This equipment handles coils ranging from 10,000 to 50,000 pounds with speed, convenience, safety.

SECO uncoilers and recoilers are designed to operate at any speed the mill requires, are available in positioning or stationary types. The positioning types feature a slideable reel base mounted on a sub-base for alignment with the processing line, actuated by an automatic edge control.

SECO also makes auxiliary equipment such as coil cars with coil lifts to simplify uncoiler loading and recoiler unloading. Available for mandrel or cone-type reels.

A staff of trained sales engineers will assist you in finding the equipment best suited to your needs. Call or write today. West Coast representative: United Machine Tool Company, Los Angeles.





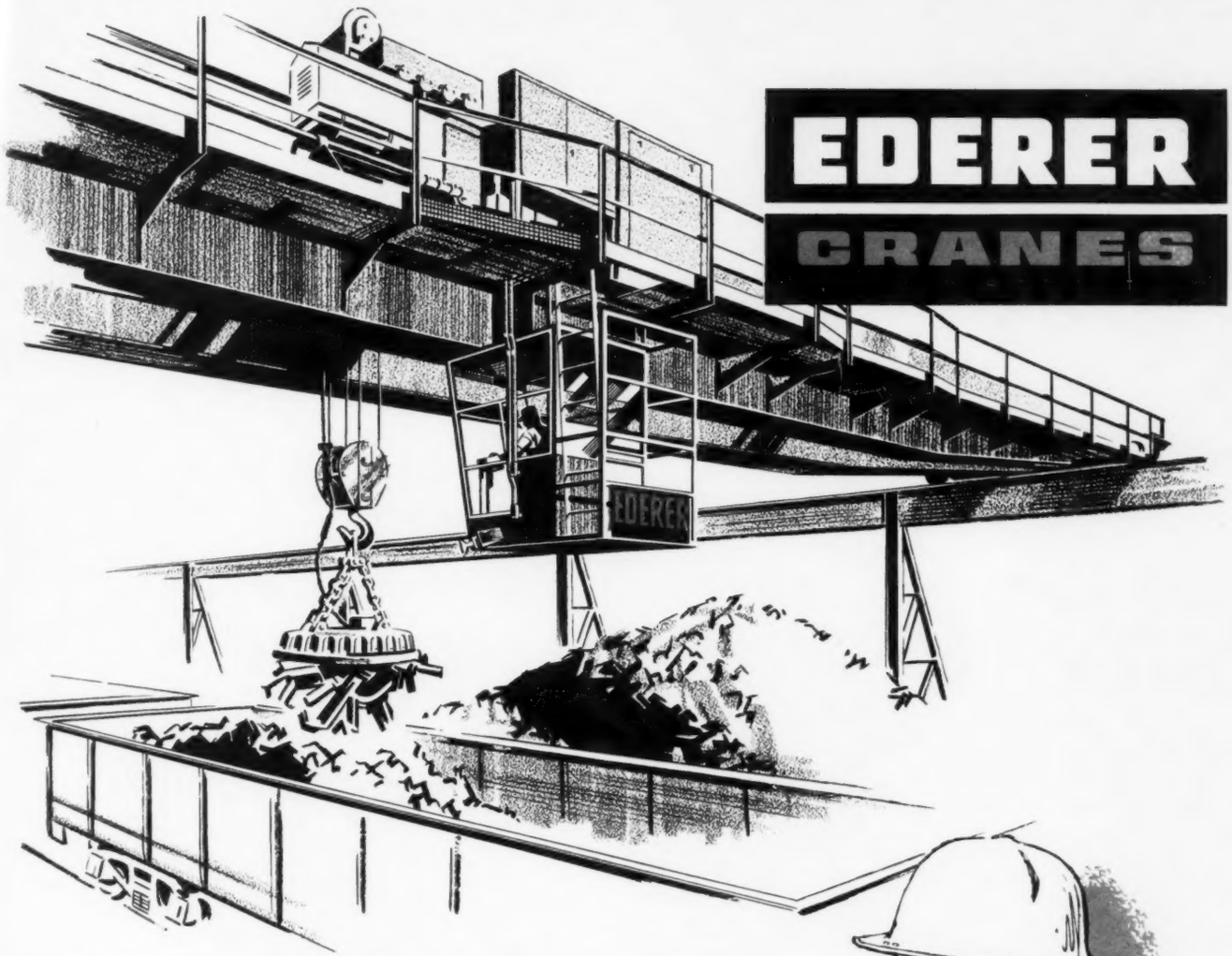
SECO STEEL MILL EQUIPMENT

- Leveling and Shearing Lines
- Combination Edging and Flattening Lines
- Tension Reels for Strip Polishers
- Narrow Strip Grinding Machines
- Slitting Lines
- Multiple Strand Pull-out Rolls and Take-up Frames
- Strip Coilers (Up and Down Type)
- Traverse Reels for Narrow Strip
- Steel Coil Up-enders
- Scrap Ballers

STEEL EQUIPMENT COMPANY

P. O. BOX 737, WARRENSVILLE STATION • CLEVELAND 22, OHIO

Affiliated with Lee Wilson Engineering Co., Inc.



"JOE HANDLES THAT 7000-POUND MAGNET LIKE A TOY...SOME CONTROLS!"

And they are some controls . . . EDERER "job-engineered" adjustable voltage DC controls can (if anybody wanted to do it) lower a load onto an egg without crushing it! This gives the crane operator a really "delicate touch" . . . makes pinpoint load spotting possible and extremely responsive hoist operation. Acceleration and deceleration are smooth . . . controlled . . . eliminating load shock and prolonging gear and cable life. Over-all crane operation is faster, smoother. Practically any load speeds may be had . . . faster for light loads, slower for the big lifts.

EDERER regularly "job-engineers" this type of controls for the cranes it designs and manufacturers . . . with exact materials handling requirements in mind . . . can do the same for YOU. It will pay you to talk over your requirements with an EDERER engineer.

370C61

EDERER

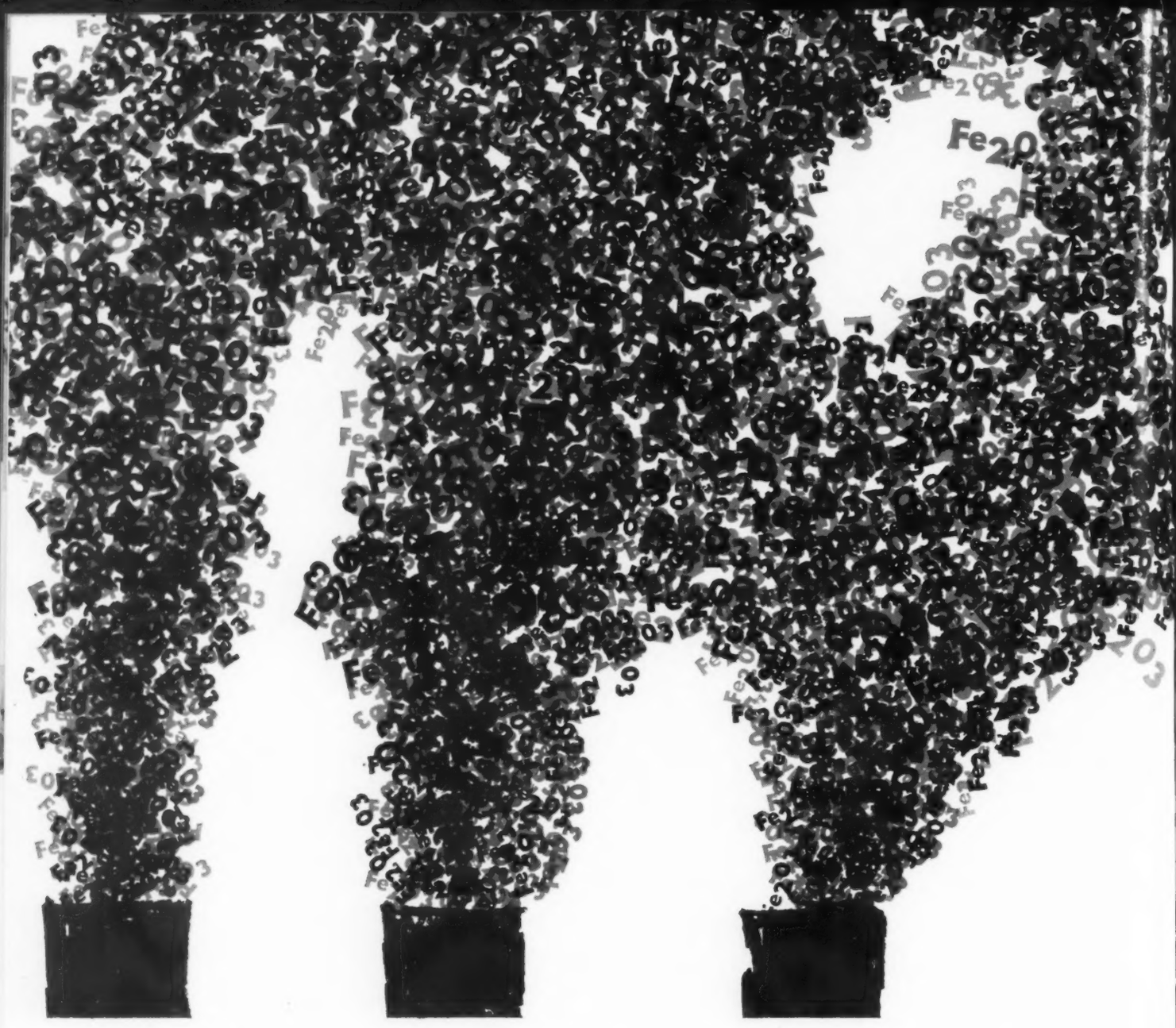
ENGINEERING COMPANY

2935 FIRST AVENUE SOUTH • SEATTLE 4, WASHINGTON

EXPORT DIVISION: 301 Clay St., San Francisco 11, California

EDERER industrial crane catalog . . . Bulletin CR-610 . . . and crane controls Bulletin CE-500 . . . sent to you gladly on request.

SINCE 1901 "JOB-ENGINEERING" CRANES AND HEAVY EQUIPMENT



USING O_2 IN YOUR OPEN HEARTH? Chemico Venturi Scrubbers do more than simply solve the air polution problems brought on by the use of oxygen in steel making. Operating and performance figures indicate that for oxygen steel converters, oxygen lanced open hearth furnaces, electric furnaces and flame scarfing, the Chemico Venturi Scrubber solves those problems with higher efficiency and at lower cost than any other method now in operation. Specifically, these are the advantages of a Chemico Venturi Scrubbing System:

CAPITAL INVESTMENT—Chemico Venturi Scrubbers can be installed for approximately 30-50% less capital cost than required for electrostatic precipitators.

OPERATING AND MAINTENANCE COSTS—Chemico Venturi Scrubbers require so little maintenance and manpower, that over-all operating costs are dramatically lower than for other methods, even though power requirements may sometimes be slightly higher.

CONSISTENT PERFORMANCE—The Chemico Venturi Scrubber attains maximum cleaning efficiency at start-up. This peak efficiency is not decreased by subsequent changes in the gas flow or other variations in process conditions.

COLLECTION AND DISPOSAL—The Chemico Venturi Scrubber collects iron oxide dust wet and recovers it dry—free of contaminants and ready for re-use. It eliminates the common and very serious problem of how to handle and dispose of dry dust collected in an electrostatic precipitator.

WATER REQUIREMENTS—The Chemico closed cycle scrubbing process eliminates water disposal problems and cuts make-up water requirements to a minimum. Normally, no more than 50-100 GPM is needed.

PROCESS FLEXIBILITY—Adjustable Venturi throat permits automatic control of furnace draft while maintaining full cleaning efficiency.

If you are considering the installation of gas cleaning equipment, a Chemico representative would be pleased to discuss performance and cost figures with you. Chemico handles the complete job:

PLANNING—DESIGN—ENGINEERING—CONSTRUCTION and START-UP.

CHEMICO

Chemical Construction Corporation, Gas Scrubber Division, 320 Park Ave., New York 22, New York

Ferndale, Mich. Chicago, Ill. Los Angeles, Calif. Houston, Tex. Bartow, Fla. Birmingham, Ala. Pittsburgh, Pa.

Equipment News...

MOTORIZED TONGS

△ Hot or cold steel slabs, in loads weighing up to 120,000 lb, are lifted quickly and safely with specially-designed motorized tongs at the plant of Weirton Steel Co., a division of National Steel Corp.

The spreader-type tongs will lift from one to seven slabs, in a pile up to 50-in. deep. Slabs ranging from 20 in. to 49-in. wide can be accommodated.

Compared to the former method of lifting slabs by wrapping chains around them, time is saved and the slabs may be piled higher, making better use of storage space. There is no need for a floorman to risk injury or to be subjected to excessive heat in attaching or removing chains.

One unit is used in carrying slabs from a railroad car to the slab storage area, and another in carrying them from the storage area to a conveyor for transfer to the heating furnace. All operations are controlled by a craneman from his cab, even when the slabs are picked up from a railroad car.

Designed and built by the Materials Handling Division of Heppenstall Co., the tongs weigh 19,275 lb. They are 11 ft-4 in. long, but are only 7 ft-1 in. wide, permitting their use where side clearance is comparatively limited. When a load is to be picked up, the arms can be positioned to any desired width of opening, reducing aisle requirements to a minimum.

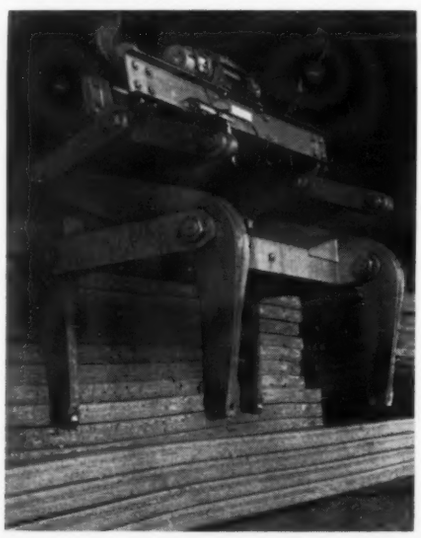
To pick up a load, the tongs are lowered over it, with the arms held open just wide enough to provide clearance. The craneman then operates an electric motor, attached to the tongs, to move the arms in until their points contact the edge of the bottom slab. As the slabs are lifted, the mechanical leverage of the tongs maintains a squeeze effect that holds the load safely. When the load is delivered, and again rests on a firm surface, the craneman uses the electric motor to open the arms, so the tongs can be lifted out of the way.

The tongs handle approximately 2700 tons of slabs during an 8-hr turn and approximately 240,000 tons a month.

Safety controls prevent the arms from opening while lifting a load.

The tongs incorporate a double clevis, on 10-ft centers, for suspension from twin crane hooks. The same design can be made for other slab widths and capacities.

Lowering motorized tongs over a load of steel slabs, note that the arms are positioned at the desired width of opening, sufficient to fit around the pile of slabs with a minimum aisle requirement. Operation of the electric motor, by the craneman in his cab, will close the arms until the lifting points make contact against the bottom slab. As the slabs are lifted, the mechanical leverage of the tongs maintains a squeeze effect that holds the load safely.



ROLL CLEANER

△ Available from Hunter Sales Corp. is an automatic roll cleaner for temper mills.

A soft abrasive cleaning block removes dust and grease, and cleans up and eliminates oxide build-up that packs into the surface texture of the work rolls.

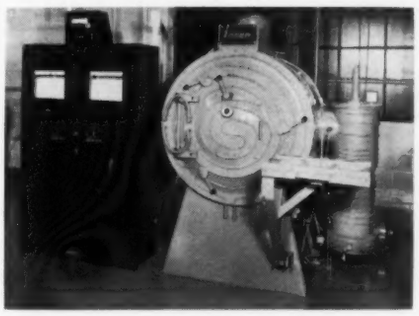
The cleaner helps increase production by continually cleaning rolls as an integral part of the rolling procedure. No downtime is required for cleaning rolls.

The long lasting cleaning blocks can be used continuously and can be quickly changed, and do not destroy the matte finish of the rolls.

Additional models are available for two-high mills, leveler rolls, pinch rolls, billy rolls, carrier rolls or any other operations where mechanical defects on the finish are a problem.

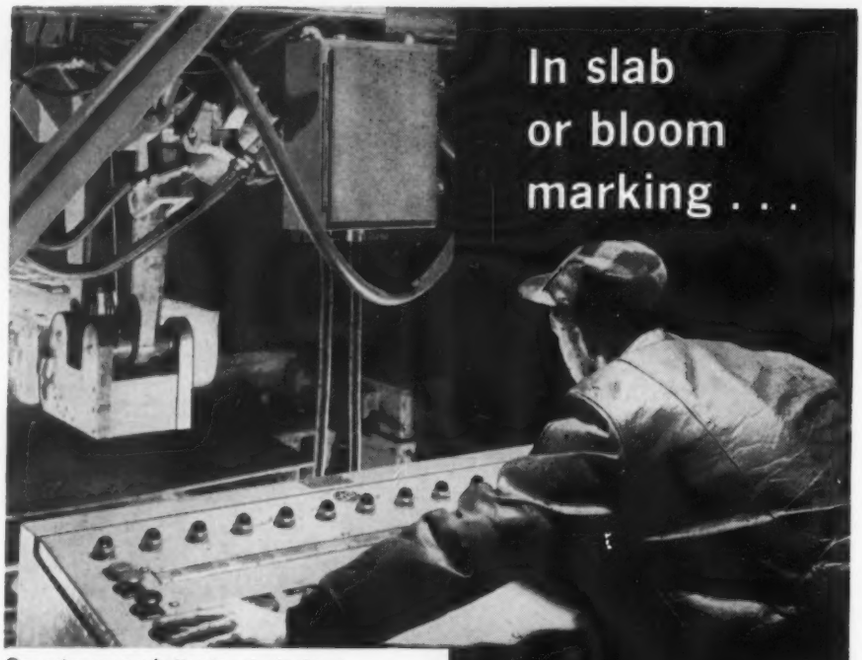
HEAT TREATING UNIT

△ A hardening process that is fully automatic and produces a bright finish on all high-speed and tool steels is announced by Ipsen Industries, Inc. The process maintains correct surface carbon concentration, holds distortion to an absolute minimum, and reduces the cost of operation to less than one half of salt treatment.



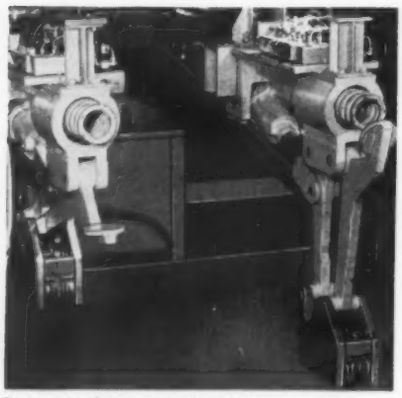
The basic equipment used is a modified vacuum unit. To operate the unit, the steel is placed in a basket on the charging platform. The operator manually opens the door, swings the loading platform into position in front of the unit and rolls the work basket into the furnace. Special ceramic rollers inside the furnace support the load during the entire heating and cooling cycles. The platform is then swung aside and the furnace door sealed. At the control cabinet, the operator sets the time at preheat soak, and the time at high heat soak. After pressing the start button, the unit will automatically perform all functions, and upon completion of the last cycle, ring a bell to signal the operator that the work can be unloaded. The unit can be immediately reloaded.

Since the work is protected from



Operator presses button to actuate stamping cycle or change characters—installed at a transfer table.

CUNNINGHAM
HAS THE
EXPERIENCE



Twin units for automatic consecutive numbering of 2½" bar billets—for installation along edge of cooling bed.

17 UNITS IN SERVICE
. . . MORE ON ORDER

Double-headed Slab Marker with 18 stamping wheels, photographed during testing—for installation over a roller line.

Under constant development for more than 13 years, Mecco Safety Slab Markers are the industry's most advanced—*the most thoroughly service-proved,* by a margin of hundreds of thousands of tons.

We'll gladly consult with you on any phase of steel industry marking. *May we send technical bulletins on Slab Markers?*

Mecco SAFETY MARKING TOOLS

M. E. CUNNINGHAM CO.
1041 CHATEAU STREET
PITTSBURGH 33, PENNA.

oxygen and other oxide producers during the entire heat treat cycle, the surface remains clean and bright and no surface carbon is depleted. This will mean that parts can often be finished prior to heat treatment since no surface decarb will have to be removed. Also, as both work and the furnace are heated together and the parts are never moved while hot, distortion is at an absolute minimum.

The unit is completely cooled and can be placed, ideally, in an air-conditioned room. There are no fumes and no special pretreatment of the material, other than normal cleaning, is required before or after heat treatment. The unit can be operated 8 hr, 16 hr or 24 hr a day with equal efficiency. The unit is completely shut down during non-production hours since no time is required for warm up or purge of the equipment. One operator can load multiple units and with electricity the only major cost, the unit can be operated for less than one half of a salt bath installation.

The equipment has a complete safety interlock that will automatically shut down the unit for the loss of any utility.

OPEN HEARTH DOOR

△ A new ram type refractory open hearth door with inverted refractory-holding ribs has been developed by Hutton Fabricating Manufacturing Corp. The door features a unique horizontal inverted ribbing design which in field operation has resulted in increasing door life over conventional ram type doors up to 100 per cent before reramming is necessary. In various tests in actual steel mill operation from 100 to 121 heats have been obtained before the refractory burned to replacement point.

Instead of running the door ribs in a convex vertical fashion, they are inverted and run concave horizontally across the width of the door. This increases the depth of the area for refractory material inside the door from approximately 2 in. to 4¾ in. Therefore refractory material has a burning distance twice as great as formerly.

The horizontal concave ribs also permit the refractory material to be securely held once it is set. The

(*Please turn to page 206*)

DAILY GRIND ALWAYS UNIFORM
with Pennsylvania Reversible Hammermills

Regardless of condition of coal or amount of hammer wear—Pennsylvania Hammermills are noted for producing a highly uniform product day after day.

Basic design and simple adjustments available to the operator on the spot make this possible.

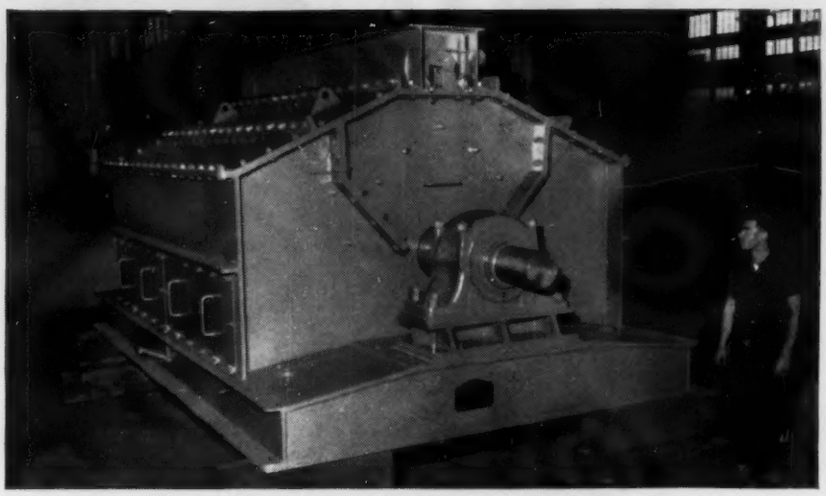
Pin point adjustments of cage-hammer clearance (by ratchet wrench and worm gear assembly) compensate for hammer wear or coal condition.

Crushing action keeps fines to minimum. Free air impact crushing in upper zone prepares coal so there is little dredging of hammers through oversize in cage-bar zone. Results—uniform grinds day after day.

DOUBLE CRUSHING AREA: DOUBLE CAGE, BLOCK AND HAMMER LIFE

No other crushers give you so much more for your money. Pennsylvania Reversible Hammermills give double the crushing area—double the life of cage bars, breaker blocks and hammers. A flick of the switch; rotor is reversed and you are using a duplicate mill.

What's more, hammers need never be hand turned, and wear is kept uniform.



• Pennsylvania Reversible Hammermill, typical of type used in by-product coke plants, ready for shipment.

With adjustable cage assemblies, hammers can be worn much further while keeping grind uniform—with no falling off of tonnage.

FREE BULLETIN

Bulletin 1040, giving a full description of the design, construction features, operation and maintenance of Pennsylvania Reversible Hammermills, can prove profitable reading for you. Write for a copy today.

PENNSYLVANIA CRUSHER DIVISION
BATH IRON WORKS CORPORATION
WEST CHESTER, PENNA.

DOUBLE DIVIDEND!
Pennsylvania Bradford Breaker cleans coal as it crushes

Famous Pennsylvania Bradford Breakers not only crush and size run-of-mine coal—they automatically remove and discharge tramp iron and other refuse. This is just one of many features giving Pennsylvania world leadership for this type of crusher. Over 60 million tons of coal annually are prepared by Pennsylvania Bradfords in coke plants everywhere.

For complete information, write and ask for Bulletin 3009.

★ ★ ★

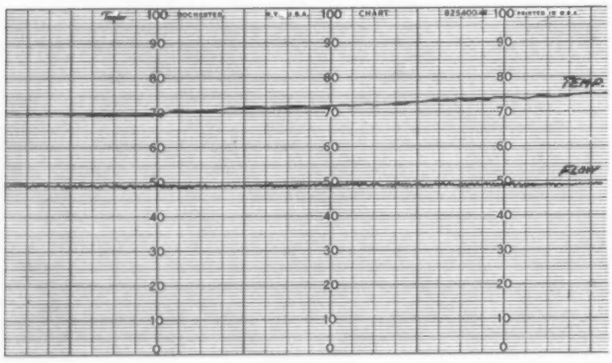
Over 50 years concentrated experience in all types of material reduction makes Pennsylvania your best source of crushers and engineering advice and service. Call on Pennsylvania with your next crushing problem. Representatives from coast-to-coast.

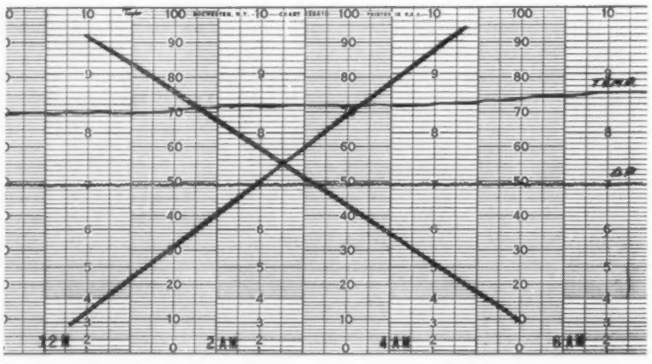
PENNSYLVANIA CRUSHERS
BATH-BUILT

NEW FROM

212T TRANSCOPE® Indicating Flow and DP Transmitter

Now . . . calibration linear with flow obsoletes sectionalized charts





SPECIFICATIONS

Range Interval: *continuously adjustable 20" to 250" w.g.*

Accuracy of Calibration: (*Referred to input*)—*Transmitter* ½%.

Static Rating: *1500 psi.*

Overrange: *Can accept full static pressure overrange, reverse or direct.*

Case: *Sturdy, die-cast aluminum, for field mounting.*

Primary Materials: *Carbon steel or Type 316 S.S. Flanges and adaptors with Type 316 S.S. trim.*

Taylor Instruments

Taylor

The only DP transmitter that can be calibrated for output linear* with flow as well as differential pressure without changing parts

Really a "transmitter with a built-in computer", the No. 212T TRANSCOPE Force-Balance Flow and Differential Pressure Transmitter can be converted from linear with flow to linear with differential pressure (liquid level) simply by calibration. It employs a liquid-filled, diaphragm sealed primary unit and a unique secondary unit in which force balance is accomplished by a powerful motion servo and spring combination. Servo power makes possible these features, unavailable in conventional transmitters:

- Ratio and cascade control without intermediate, separate square root extraction.
- Simple analog computations involving flow and other variables pneumatically without an extra "black box".
- Elimination of the need for sectionalized charts.
- Indication at the process on a big 11¾" scale, visible up to 35 ft. away.

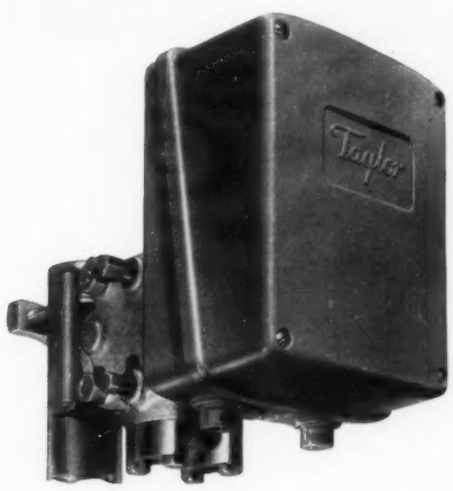
This ingeniously designed transmitter may be Calibrated Linear with Differential Pressure or Calibrated Linear with Flow, and can be either indicating or non-indicating. For computer control, for example, linearized flow is a logical short cut.

Use of a liquid-filled primary gives positive overrange protection. Working parts in the primary are exposed only to the filling liquid—not to the process. Static pressure compensation is inherent in the unique thrust pivot of the force beam. Connections are extremely convenient. Mounting facilities are more adaptable than ever before.

With all its outstanding features you pay no premium for the 212T Transmitter. Ask your Taylor Field Engineer for a demonstration, or write for **Bulletin 98413.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Ontario.

**Even without this unique feature, the 212T would still be a superior DP transmitter.*

Convenient through-bolted flanges for easy servicing. Process connections top, bottom or side.



213T non-indicating model shows rear mounting and bottom process connections.

MEAN ACCURACY FIRST

(*Continued from page 202*)

deeper continuous refractory bed protects the door to a greater extent against burn-outs. The ram type design eliminates studding used in older doors which required maintenance for replacing numerous studs and clips. Reramming open hearth doors is greatly simplified as only the refractory residue need be removed and the door is ready for immediate reramming. The doors are provided with eight inspection holes for inspecting the refractory material to determine when reramming is necessary.

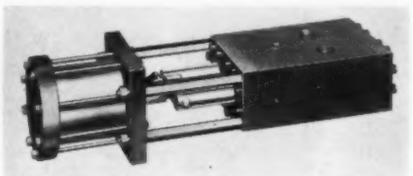
CONTROL VALVE

△ A series of lever or pilot operated dual sealing type, two-way hydraulic control valves, especially suited for use in hydrostatic testing of tubing, pressure vessels and similar items, is announced by Hunt Valve Co.

Capable of holding rated pressure in both directions, thus eliminating the need for additional external check valves, the dual sealing valves are suitable for pressures up to 5000 psi. Valve U-packers face in toward valve ports, so any intensification of pressure results in tighter sealing.

In high pressure hydraulic service, the valve can be closed and the inlet pressure dropped, with high pressure still held on the outlet side. Also, high pressure on the outlet side can be intensified for testing, within valve pressure rating limits, without leakage or damage to the packers, the manufacturer states.

The valve is designed to release pressure on the packers, placing

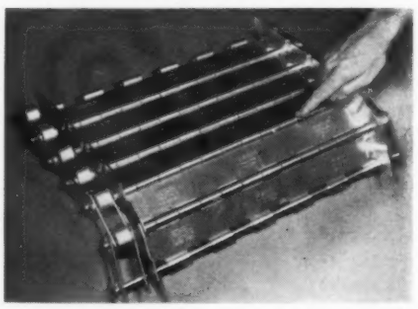


them in hydraulic balance, as the plungers shift. As a result, the packers "float" across the ports, minimizing wear and providing maximum service life, it is claimed.

The dual sealing type two-way hydraulic control valves are offered in ½, ¾, 1, 1¼, 1½ and 2-in. sizes. Available pressure ranges are 2000, 3500 and 5000 psi.

HINGED-STEEL BELTING

△ A new line of heavy-gage, hinged-steel conveyor belting, with specially designed short-pitch belt links, is announced by the May-Fran Manufacturing Co., a division of Fischer & Associates, Inc. The new link design is compatible with existing conveyors using hinged-steel belting. The shorter-pitch link permits a



considerable reduction in over-all section depth of conveyor designs.

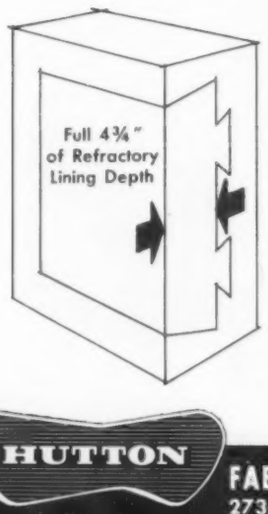
Developed for industrial conveyor applications where operating conditions are more rugged than normal, the heavier gage steel belting is assembled from patented-

DOUBLE DOOR LIFE

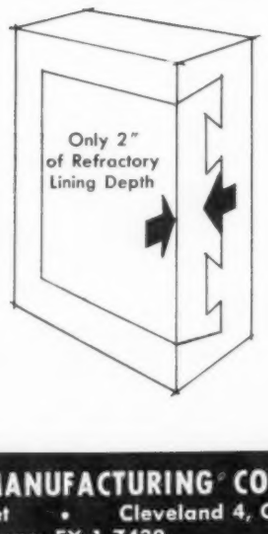
Patent Pending

The new Hutton Ram Type Door features a new *concave* refractory-holding rib design. This increases the uninterrupted refractory thickness area over conventional *convex* rib type doors from 2" to 4¾". Tests in actual open hearth operation obtained 100 to 124 heats before re-ramming required. Ram type Hutton doors eliminate troublesome, costly studding of doors—no clips, studs or welding required to re-ram. Investigate this cost-cutting, field proven door today! FREE BULLETIN 561 fully describes Hutton Ram Type Doors. Write for your copy today.

NEW RAM TYPE HUTTON DOOR



CONVENTIONAL RAM TYPE DOOR



HUTTON

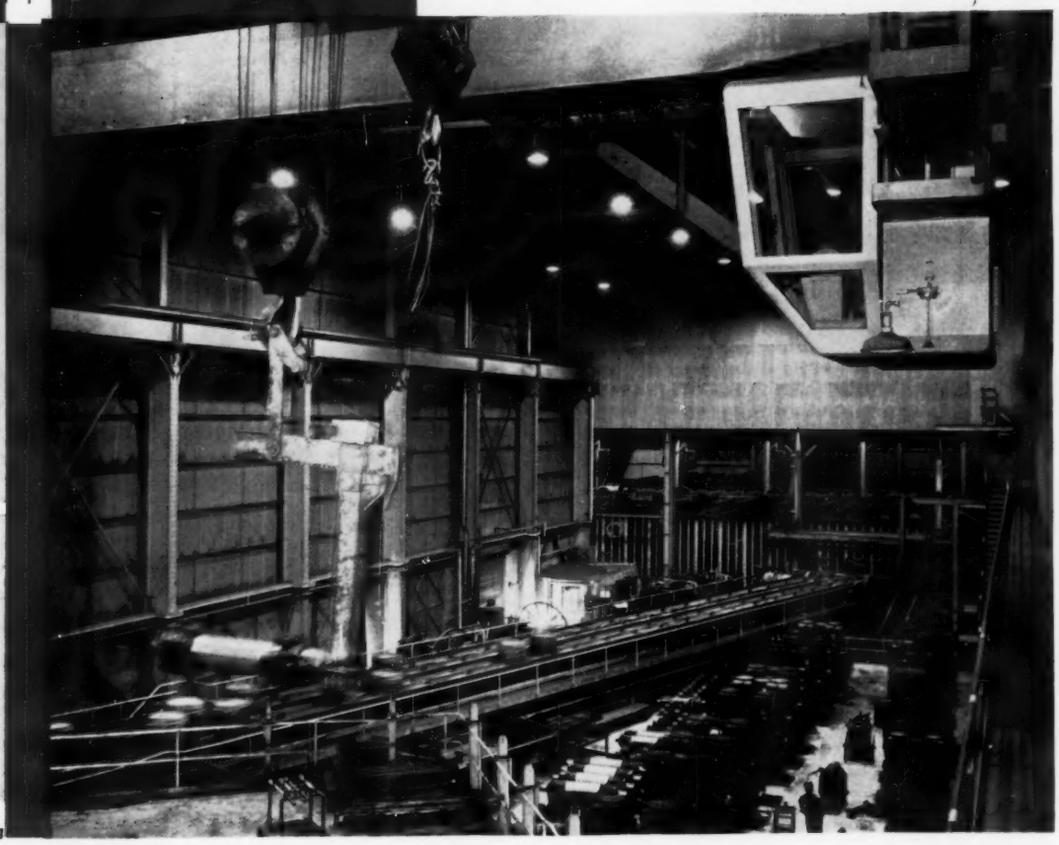
FABRICATING MANUFACTURING CORP.
2736 East 79th Street • Cleveland 4, Ohio
Telephone: EX 1-7432

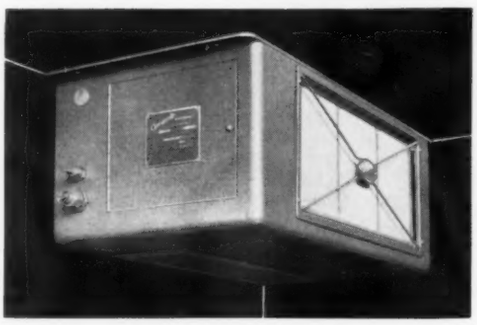
Open Hearth and Electric Furnace Doors and Frames • Oxygen Lances
Special Steel Mill Fabrications • Water Line Purifiers

Correct-Air = 5

It ❶ cools, ❷ dehumidifies, ❸ removes dust, ❹ absorbs fumes and gases, ❺ heats

Patent Pending





Split and Self-contained systems, Water-cooled and Air-cooled, with conditioners for any location, add up to the most diversified line of heavy duty air conditioning offered today. From top to bottom: floor conditioner; seat-type conditioner; ceiling conditioner. In addition, Wall and Exterior-mounted conditioners complete another ***"5"***, making Correct-Air the only builder with 5 basic installation styles.

Invest in This Proven Aid to Maximum Production

Raise human efficiency in hot spots to the level of your mechanical progress. Give your men clean, healthful air summer and winter. Watch the improvement in operator alertness and safety; enjoy better industrial relations. You'll be repaid many times over.

Correct-Air's many models can be adapted to your exact conditions and requirements. A thorough Correct-Air analysis is gratis for the asking. Also, write today for your copy of Bulletin 2001-E.

Correct-Air

CORRECT-AIR CORPORATION

Sold by **JAMES CAMPBELL SMITH, INC.**

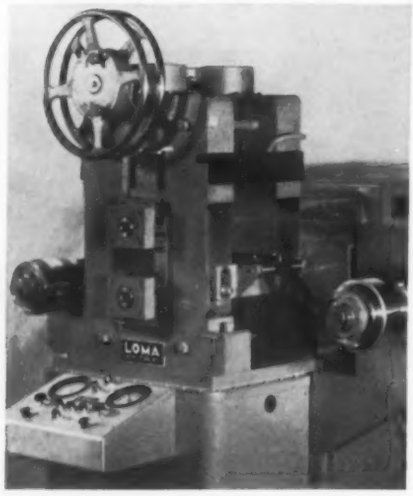
Both of **WILLOUGHBY, OHIO**

JCS

Also, America's largest builders of air-conditioned pulpits and crane cabs

NEWS FROM

LOMA



This rugged and versatile reversing 2-high / 4-high combination mill brings high-precision rolling of thin-gauge ferrous and non-ferrous strip within reach of the smaller re-rolling mill, metals pilot plant and research laboratory. Occupying only 35 sq. ft. of floor space and involving a cost of less than $20,000, the machine handles up to 6 in. wide strip at rolling speeds up to 250 ft. per min. with accurate front and back tension control.

The new 8 in. mill is furnished with two sizes of 4-high work rolls, made of either alloy tool steel or solid tungsten carbide: the 1½ in. size is used for normal cold reduction down to 0.002 in. thickness, and the ¾ in. size allows special ultra-thin finishing to gauges of less than 0.001 in. In the 4-high setup, the machine handles up to ⅛ in. gauge; the 2-high arrangement is used for the hot or cold breakdown of heavier materials up to 1 in. thick, but is also available for skin pass rolling of thin strip.

The production of close-tolerance stock is assured by an exceptionally rugged mill design, employing steel housings of 160 sq. in. post area, super-precision needle roller journal bearings of 175,000 lb. separating force capacity, a heavy-duty mill drive with herringbone gearing and universal joint spindles, and twin-handwheel worm drive screwdowns. The machine is powered by a four-speed reversing drive offering constant horsepower from 40 to 250 ft. per min. rolling speed.

The outstanding feature of the new machine is its reversing strip coiling attachment allowing the two-way rolling of strip under tension control with no more effort than a mere flick of a selector switch. Mounted on brackets at either side of the mill, the two coiling shafts carry 8 in. diameter reels designed for a coil buildup of 6 in. Both shafts are driven from the pinion stand and are provided with dual air-operated slip clutches and brakes of ultra-sensitive, low-inertia design. Selective operation through solenoid valves and pressure regulators precisely controls the front and back tensions desired for any given mill pass.

LOMA

MACHINE MFG. CO., INC.

114 East 32nd Street

New York 16, N. Y.

design hinged links. Fabricated from ⅛-in. thick steel, each individual belt link has a 2½-in. pitch. (Pitch is the distance between centerlines of link through holes.) The shorter 2½-in. pitch allows the assembled hinged-steel belt to run on sprockets with a pitch diameter as small as five in. As a result, over-all conveyor depth can be as little as 8½ in.

Hinged-steel belting using these new links can be supplied in virtually any practical width. Individual links are produced in widths up to 18in. Belts wider than 18 in. are assembled simply by threading multiple links on the through rods.

The new belting was developed for handling materials such as nuts, bolts, stampings, castings and other items which are not big physically, but are heavy in weight. The links can be furnished with increased clearance between link through holes and the through pin. This feature offers design advantages when the belting is used in water quench or water cooling applications where corrosive action is often prevalent. For elevated temperature applications, such as conveying hot metal parts, the link clearances are made slightly larger.

Belting made from the new link design can also be supplied in other materials to meet special conveying requirements.

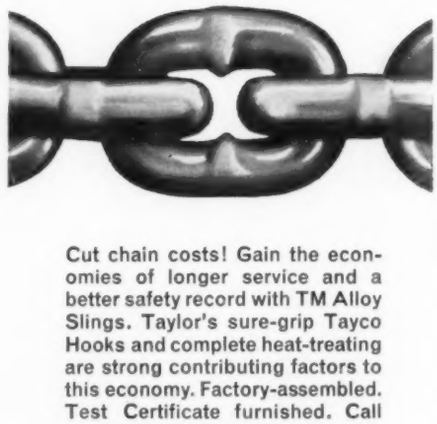
Book Reviews

"Physical Chemistry of Process Metallurgy Part 1" (Volume 7) and Part 2 (Volume 8), edited by George R. St. Pierre, have been published recently by the Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. Volume 7 contains 644 pages, 6 x 9 in., is cloth bound, and sells for $22.50. This is the work of 61 contributors. Volume 8 contains 727 pages, 6 x 9 in., is cloth bound, and sells for $25.00. Here is presented the work of 69 contributors. Both volumes consist of papers presented during an international symposium sponsored by the Physical Chemistry of Steelmaking Committee of the Iron and Steel Div., the Physical Chemistry of Extractive Metallurgy Committee of the Extractive Metallurgy Div., and the Melting and Casting Committee of the Institute of Metals Div., American Institute of

VALUED FOR

Economy

TM alloy slings



Cut chain costs! Gain the economies of longer service and a better safety record with TM Alloy Slings. Taylor's sure-grip Tayco Hooks and complete heat-treating are strong contributing factors to this economy. Factory-assembled. Test Certificate furnished. Call your distributor, steel warehouse, hardware wholesaler or write for Bulletin 14A today.

S. G. TAYLOR CHAIN CO., Inc.

Plants: Hammond, Indiana

3505 Smallman St., Pittsburgh, Pa.

Prompt repairs on alloy slings in both plants.

TM Taylor Made CHAIN SINCE 1873

Mining, Metallurgical, and Petroleum Engineers, Pittsburgh, Pa., April 27, 28, 29, 30, May 1, 1959. The papers are illustrated with charts, graphs and tables. References are given; and discussions are included.

"High-Strength Steels for the Missile Industry," edited by H. T. Sumsion, has been published recently by American Society for Metals, Metals Park (Novelty), Ohio. The book contains 276 pages, 8½ x 11 in., is cloth bound, and sells for $12 within continental United States and Canada (elsewhere add $2.00 postage). The book consists of the Proceedings of the Golden Gate Metals Conference held in San Francisco, Calif., February 4, 5, 6, 1960, sponsored by the Golden Gate Chapter of the American Society for Metals. Ten papers are included, by fourteen authors. More than 200 illustrations, tables, charts and graphs are included.

"The British Iron and Steel Research Association (BISRA) Annual Report, 1960," has been published by the Association. Copies may be obtained from the Association, 11 Park Lane, London W. 1, ENGLAND. This book reports on the activities of the several divisions during 1960. The report of the Ironmaking Division summarizes the year's activity in burden preparation, blast furnace process and practice, ironmaking techniques, blast furnace refractories, coke research. The Steelmaking Division reports on 1960 activities in oxygen in steelmaking, open hearth steelmaking, electric-furnace steelmaking, converter steelmaking, continuous casting, conventional casting. The coverage of each subject is brief, but complete. The Mechanical Working Section, Plant Engineering and Energy Division, Metallurgy (General) Division, Chemistry Dept., Physics Dept., Operational Research Dept. all report briefly on work done during 1960. A short chapter is included defining the object of the Development and Information Services of BISRA. There are six appendices in the report. Appendix I—Reports lists reports (by division) and the status of each (whether published and publication reference) or restricted to membership. Also included is a "Publications for Sale" and "Publications Available from Book-sellers" list. Other appendices list member firms; committees and panels; council, committee and panel members; licensees; staff; and extramural research officers, 1960.

"AGMA Gear Classification Manual for Spur, Helical and Herringbone Gears (AGMA 390.01 May, 1961)," has been published recently by the American Gear Manufacturers Assn., No. 1. Thomas Circle, N. W., Washington 5, D. C. This manual divides spur, helical and herringbone unassembled gears in the range of ½ to 200 DP into 16 quality classes. Fine-pitch and coarse-pitch sections are printed on different color paper for quick reference. The gear designer or user can readily select the most economical, but satisfactory, gear for the intended application. The user is first directed toward a section dealing with typical or specimen example end uses by quality number; an examination of the tolerances given for various elements in the apropos section enables the most suitable selection, since the quality number, coupled with a material and heat treat designation (if required) gives the gear supplier enough data to proceed with the job. Copies are

Continuous Crushing of Hot, Highly-Abrasive Materials

McLANAHAN SINCE 1835

SINTER BREAKER

- Water cooled crushing roll, roll shaft and bearings
- Integral 9" hard-surfaced teeth
- Non-plugging, tapered, Ni-hard grate bars

Designed to crush any volume of material that can be discharged to it by the sinter machine, the McLanahan Sinter Breaker is rigid and powerful—constructed for continuous, low-maintenance performance. Standard widths, 72" and 94"—other sizes custom engineered.

Write for details.

McLANAHAN Corporation

HOLLIDAYSBURG, PENNSYLVANIA

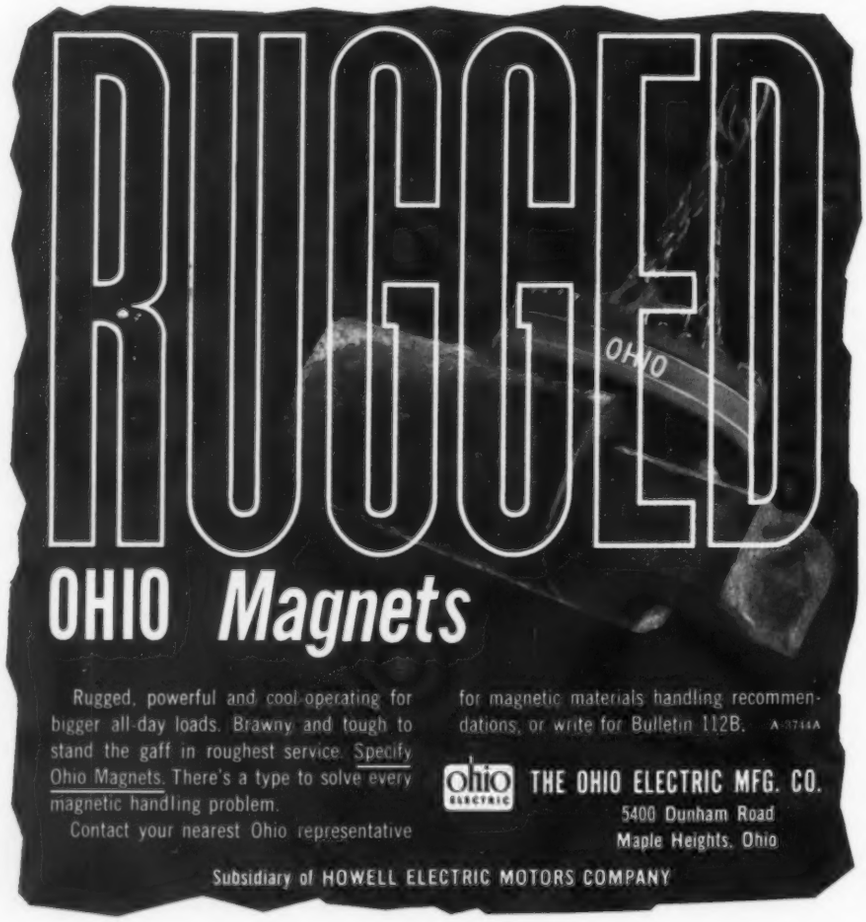
available from the AGMA at $1.50 per copy to non-AGMA members.

"Powder Metallurgy," edited by Werner Leszynski has been published recently by Interscience Publishers, Inc., 259 Fifth Avenue, New York 1, N. Y. The book contains 847 pages, 6 x 9 in., is cloth bound, and sells for $25. Here is the proceedings of an international conference held in New York, June 13, 14, 15, 16, 17, 1960, under the joint sponsorship of the Metal Powder Industries Federation and the Powder Metallurgy Committee of the Institute of Metals Div., The Metallurgical Society, American Institute of Mining, Metallurgical, and Petroleum Engineers. Papers included on the conference program covered powder metallurgy as a science, a technology and an industry. Two symposia on the subjects of the mechanism of sintering of a single metal or compound and several others with dispersion strengthening; papers on powder metallurgy technology covering newer methods for forming metal powder into useful shapes, developed in recent years. The various papers are well illustrated.

"Industrial Furnaces," Vol. 1 (fifth edition) by W. Trinks and Matthew Mawhinney was published recently by John Wiley & Sons, Inc., 440 Park Avenue South, New York 16, N. Y. The book contains 486 pages, 6 x 9 in., is cloth bound, and sells for $17. This book recognizes and discusses the basic principles underlying all furnace design and operation. The present edition includes the advances and improvements since the publication of its predecessor. Among the many changes and additions are: reorganization of the material in order to accord better with the steps taken in the actual design of a furnace; a separate chapter on the theory and calculation of heat transfer within a furnace enclosure, including radiation and convection transfer to and from the furnace gases; material on obsolete furnace designs has been deleted and replaced by discussion of more modern types of furnaces. Book has expanded treatment of the capacity of modern forced-convection furnaces and of modern axial heating furnaces.

"Tool Steel Simplified" (Third Edition) (completely revised) by Frank R. Palmer and George V. Luerssen has been published recently by The Carpenter Steel Co., Reading, Pa. The book contains 595 pages, 6 x 9 in., is cloth bound and sells for $2.50 in the United States, elsewhere $3. The purpose of this book is to give the toolmaker a comprehensive, accessible source of information that can be translated into solutions for tool and die problems. In this third edition, tool steel terms have been revised to cover in a broad way the current recognized practices; the matched set method has been revised to reflect the growing importance of alloy tool steels; under the twelve matched tool steels, the AISI numbers have been added for convenient reference. Heat treating methods and equipment have been extensively revised to include the new equipment and methods of control recently made available to hardening rooms, particularly those having to do with furnace atmospheres. The coverage of high speed steel has been rewritten to fit a changeover from tungsten high speed steels to molybdenum types.

"Light Gage Cold-Formed Steel Design Manual 1961 Edition" (third edition) and Commentary thereon have been published recently by the American Iron and Steel Institute, 150 East 42nd Street, New York 17, N. Y. The design manual contains 115 pages, 6 x 9 in., is cloth bound, and sells for $1.00. The commentary contains 60 pages, 6 x 9 in., is bound in heavy paper, and sells for 50¢. Both are available from the AISI. In this third edition, the manual has been revised and enlarged. The 1960 Edition of the Specification, reflecting rapid technical developments and the results of continued research is included. The illustrative examples and the tables and charts have been revised and expanded to conform with the revisions to the specification and to further simplify the application of the specification to design. The manual provides information for determining the safe load capacities and deflections of sections made of any combination of flat elements formed from sheet or strip steel. The tables of structural properties are useful not only in selecting from the sections shown but also for approximating the corresponding properties of similar sections.


RUGGED
OHIO
OHIO Magnets
Rugged, powerful and cool-operating for bigger all-day loads. Brawny and tough to stand the gaff in roughest service. Specify Ohio Magnets. There's a type to solve every magnetic handling problem.
Contact your nearest Ohio representative for magnetic materials handling recommendations, or write for Bulletin 112B. A-3744A
ohio ELECTRIC
THE OHIO ELECTRIC MFG. CO.
5400 Dunham Road
Maple Heights, Ohio
Subsidiary of HOWELL ELECTRIC MOTORS COMPANY

THE ENGINEERING MART

WHERE TO BUY
EQUIPMENT FOR SAL
POSITIONS VACAN
POSITIONS WANTE

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

WHERE TO BUY

CHICAGO DISTRICT

PAUL W. WENDT & SONS
MANHATTAN BLDG., CHICAGO 5, ILL.

District Representatives for

A. W. CADMAN MFG. CO.
Since 1920

HUNTER SAW & MACHINE CO.
Since 1921

GRAFO COLLOIDS CORP.
Since 1943

EHRET AND KINSEY
Board of Trade Bldg., 141 West Jackson Blvd.
Chicago 4, Illinois Wabash 2-0449

Representing
FARVAL DIVISION
and

CLEVELAND WORM & GEAR DIV.—33 years of EATON MANUFACTURING CO.

LUBRICATION PRODUCTS COMPANY—25 Years "Stapax" Journal Lubricators

ZURN INDUSTRIES, INC.—10 Years "Amerigear" Flexible Couplings

"AMERIGEAR-BLISS" SPINDLE COUPLING DIVISION, E. W. BLISS CO.

OLSEN MFG. CO.—Conveyor Lubricators

Also 3904 West Vliet St., Milwaukee 8, Wisc.
Phone: Division 2-7844

OUR PRODUCTS REDUCE MAINTENANCE

OHIO DISTRICT

The* CALVERT *Co.

***Producers of* Calvert Bus**

- BAR BUS FABRICATION
- CABLE LEADS
  Air and liquid cooled
- JUNCTION BOXES,
  600 to 23,000 volts
- HIGH AMPERE TERMINALS

ED. 3-1944
19851 Ingersoll Dr., Rocky River 16, O.

The C. W. THOMSPON COMPANY
"Wired Communication Specialists"

- Loudspeaking Communication & Paging
- Battery Operated Portable Equipment

1718 Tytus Avenue Middletown, Ohio
GArden 2-5441

PITTSBURGH DISTRICT

METALLIC RECUPERATORS
(Air Preheaters)
For application to soaking pits, heating, and other types of metallurgical furnaces.
HAZEN ENGINEERING CO.
184 Sandy Creek Road (Penn Township)
P.O. Box 10597 PITTSBURGH 35, PA.
CHurchill 2-1750

W. G. KERR CO., INC.
1005 Liberty Ave. PITTSBURGH, PA.
Phone ATlantic 1-4692
Representing:
FOOTE BROS.—Gears and Speed Reducers
REEVES—Variable Speed Drives
THOMAS—Flexible Couplings
WICHITA—Air Tube Disc Clutches & Brakes
VICKERS—Magneclutches & Brakes
TELSMITH—Telsmith Crushers
CULLEN-FRIESTEDT—Sheet Lifters—Welding Positioners—Trach Cranes

---

J. GUY GRIFFITH COMPANY
1251 UNION TRUST BLDG.
PITTSBURGH 19, PA. PH. AT 1-3853

PROCESSING MACHINERY
ENGINEERING SERVICE and SALES

***"Ajax"* Dihedral Couplings—**
The spindle shaft coupling designed and engineered for rolling mill service.

***"Ajax"* Standard Flexible Couplings & Shaker Drives.**

***"Productive"* Vibrating Screens for processing separations.**

***"Abbe"* Ball and Pebble Mills, Mixers, Sifters and Disposal equipment for processing operations.**

***"Beach-Russ"* Hi-Vacuum Pumps, Compressors and Gas Boosters.**

***"Elion"* Ultrasonic Inspection and testing equipment.**

***"RCA"* Electronic Metal Detectors**

Special equipment for processing industries, engineered and designed

---

ROLLING MILLS and EQUIPMENT
FRANK B. FOSTER, INC.
2220 OLIVER BUILDING PITTSBURGH 22, PA.
Cable Address "FOSTER" Pittsburgh

PITTSBURGH (Continued)

RITTER ENGINEERING CO.
PITTSBURGH—CHICAGO—MILWAUKEE
Engineers • Distributors • Contractors
Specializing in Lubrication and Hydraulic Systems; Transmission and Conveying Systems; System Components
"DOING SPECIAL JOBS THAT OTHERS TURN DOWN IS OUR BREAD & BUTTER!"

Used
STEEL MILL EQUIPMENT
Rolling Mills
Cranes — Machine Tools
TIPPINS MACHINERY CO.
Pittsburgh 6, Pa.

ELECTRICAL INSTALLATIONS
PATTERSON EMERSON COMSTOCK, INC.
PITTSBURGH, PA.
313 EAST CARSON ST. PITTSBURGH 19, PA.

REBUILT MILL MOTORS
M.G. SETS — TRANSFORMERS
DUQUESNE ELECT. & MFG. CO.
PGH. 6, PA. MO-15800

Rebuilt
ELECTRICAL EQUIPMENT
M-G SEYS **AC & DC MOTORS**
TRANSFORMERS **CRANES**
MAGNETIC CONTROL **MONO-RAIL HOIST**
MOORHEAD Elect. Machy. Co.
Pittsburgh 28, Pa.

CONSULTING ENGINEERS

MIELE ENGINEERING SERVICE
EXPERIENCED IN STEEL INDUSTRY
1. CONSTRUCTION ENGINEERING
2. MILL REVAMPING
3. SPECIAL EQUIPMENT

220 E. Market St. Warren, Ohio
Telephone EXpress 24000

THE ENGINEERING MART

Consulting Engineers (Continued)

W. VANCE MIDDOUGH & ASSOCIATES
Consulting Engineers
DEVELOPMENT • DESIGN • LAYOUT
STEEL MILL • HEAVY INDUSTRIAL
Frederick Building Cleveland 15, Ohio
Prospect 1-2060

MARTIN J. CONWAY
Consulting Fuel Engineer
111 South Duke Street Millersville, Pa.
Telephone: TRinity 2-7153

HOUSER AND CARAFAS ENGINEERING CO.
Engineering for Industry
4 Smithfield Street Pittsburgh 22, Pa.
Phone: GRant 1-9929

POSITIONS VACANT

STEEL MILL ENGINEER

for plant situated in Great Britain (Midlands). Experienced in milling and rolling of stainless steel. Applicant should be qualified to modify existing blooming and billet mill and to install and operate facilities for rolling slabs and bars.

Box 701, Iron and Steel Engineer,
1010 Empire Building, Pittsburgh 22, Pa.

STEEL MILL ENGINEER

for position as Mill Manager in Argentina. Plant situated within 50 miles of Buenos Aires. Require graduate rolling mill engineer with at least 5 years experience in all aspects of structural and merchant bar mill and with good managerial abilities. Knowledge of the Spanish language preferred. Applicant must be fully qualified to supervise and operate existing facilities as well as to develop modernization and expansion program.

Box 702, Iron and Steel Engineer,
1010 Empire Building, Pittsburgh 22, Pa.

Consulting Engineers (Continued)

ROSS E. BEYNON
Consultant
ROLLING LAYOUT AND ROLL DESIGN
7658 Coles Avenue Chicago 49, Illinois
Telephone SAginaw 1-3466

IRA E. KING
Consultant
Production Problems in Mill Practice
Specialist in Alloys of Steel
2434 Hay Street Easton, Pa.
Telephone — Easton BL 3-3858

THE OSBORN ENGINEERING CO.
Consultants and Designers
HEAVY INDUSTRY
PIERS AND DOCKS • LABORATORIES
7016 Euclid Avenue, Cleveland 3, Ohio
Express 1-3380

AUBURN & ASSOCIATES, INC. ENGINEERS
COMPLETE
ENGINEERING • DESIGN • LAYOUT
FOR
STEEL MILLS AND HEAVY INDUSTRY
Pittsburgh office
1051 Brinton Road, Pittsburgh 21, Pa.
Telephone CH. 2-7120
Detroit office
3309 W. Lafayette Blvd.,
Detroit 16, Mich. TA. 6-6680

EQUIPMENT WANTED

WANTED TO BUY
Medart 6 or equivalent rotary straightener for 4" diameter high tensile HOT ROLLED BARS
RAMSEYER & MILLER, INC.
11 W. 42nd St. New York 36, N.Y.

THE COST OF AN AD
ONE COLUMN IN. IS $10.00
PER INSERTION

Wanted: highly productive U. S. manufacturer of
cold-extruded steel parts

interested in quantity sales to the automobile, arms, optical, and/or other industries in the Federal Republic of Germany. Please write to **Box No. MI 85 334 c/c CARL GABLER WERBEGESELLSCHAFT MBH., Karlsplatz 13, Munich 2, Germany.**

One million people alive today have been cured of cancer! Read why!

Many cancers can be cured —if detected in time! Your best insurance against cancer is an annual health checkup —and knowing the 7 danger signals of cancer!

WHAT DOES a doctor mean when he says his cancer patient has been *cured?* He means the patient is alive and well, without evidence of the disease, five years after diagnosis and treatment.

There are over a million Americans who have been cured of cancer—because they *acted in time!* Because of early treatment. Because they had annual health checkups. Because they knew the 7 danger signals of cancer.

These are listed below. Study them. Remember them. You might save your life that way!

The 7 danger signals of cancer

1. Unusual bleeding or discharge.
2. A lump or thickening in the breast or elsewhere.
3. A sore that does not heal.
4. Change in bowel or bladder habits.
5. Hoarseness or cough.
6. Indigestion or difficulty in swallowing.
7. Change in wart or mole.

If your signal lasts longer than two weeks, see your doctor. Only he can tell if it is cancer. Guard your family. Fight cancer with a checkup —and a check to the:

AMERICAN CANCER SOCIETY

INDEX TO ADVERTISERS

JULY, 1961

A

Aetna-Standard Div., Blaw-Knox Co. 1
Air Preheater Corp., The 186
Alemite Div., Stewart-Warner Corp. 173
Alliance Machine Co. Cover 2
American Manganese Steel Div., American Brake Shoe Co. 193
American Shear Knife Co. 47
American Waldrich Mfg. Corp. 33
Atlas Car & Mfg. Co., The 168

B

Badall Co., Inc., The 50
Bailey Co., William M. 164
Bailey Meter Co. 62
Baldwin-Lima-Hamilton Corp., Industrial Equipment Div. 23
Bearings, Inc. 155
Bethlehem Steel Co. 2
Birdsboro Corp. 64
Blaw-Knox Co., Aetna-Standard Div. 1
Blaw-Knox Co., Foundry & Mill Machinery Div. 197
Bliss Co., E. W. 15
Bloom Engineering Co., Inc. 28
Brooks Oil Co., The 9
Browning & Co., Inc., Victor R. 37

C

Chain Belt Co. 166
Chemical Construction Corp. 200
Cities Service Oil Co. 169
Cleveland Crane & Engineering Co. 12
Cleveland Worm & Gear Div., Eaton Mfg. Co. Cover 3
Coronado Steel Co. 51
Correct-Air Corp. 207
Cunningham Co., M. E. 202
Cutler-Hammer, Inc. 44, 45

D

Davy and United Instruments Ltd. 8
Diamond Electronics, Div. of Diamond Power Specialty Corp. 170, 171
Dixie Bearings, Inc. 155
Drever Co. 154

E

Eaton Mfg. Co., Cleveland Worm & Gear Div. Cover 3
Ederer Engineering Co. 199
Electric Controller & Manufacturing Div., Square D Co. 38, 39, 185
Electric Machinery Mfg. Co. 191
Electro-Alloys Div., American Brake Shoe Co. 137
Elwell-Parker Electric Co., The 18
Euclid Electric & Mfg. Co., The 21

F

Feller Engineering Co. 149
Firth & John Brown Ltd., Thos. 7
Foxboro Co., The 42

G

Garlock Inc. 160
General Electric Co. 16, 17, 196
General Steel Industries, Inc., National Roll & Foundry Div. 60
GPE Controls, Inc. 140

H

Hallden Machine Co., The 181
Harbison-Walker Refractories Co. Cover 4
Harnischfeger Corp. 175, 176
Homestead Valve Mfg. Co. 177
Hunt Valve Co. 192
Hunter Sales Corp. 161
Hutton Fabricating & Mfg. Corp. 206
Hyde Park Foundry and Machine Co. 167

I

Industrial Equipment Div., Baldwin-Lima-Hamilton Corp. 23

J

Johns-Manville Corp. 40, 41

L

Larco, Inc. 153
Leeds & Northrup Co. 32
Link-Belt Co. 31, 146
Loma Machine Mfg. Co. 208

M

May-Fran Mfg. Co. 187
McLanahan Corp. 209
Mesta Machine Co. 182
Metal Blast, Inc. 194, 195
Minneapolis-Honeywell Regulator Co. 152, 153
Mobil Oil Co. 25, 26, 27
Morgan Construction Co. 43, 66
Morgan Engineering Co., The 52

N

National Carbon Co., Union Carbide Corp. 34, 35
National Castings Co. 150
National Electric Coil Div., McGraw-Edison Co. 6
National Roll & Foundry Div., General Steel Industries, Inc. 60

O

Ohio Electric Mfg. Co., The 210
Ohio Steel Foundry Co., The 162

P

Pennsylvania Crusher Div., Bath Iron Works Corp. 203
Pennsylvania Engineering Corp. 61
Pennsylvania Flexible Metallic Tubing Co. 167
Pittsburgh Engineering & Machine Div., Textron Inc. 63
Plibrico Co. 24
Poole Foundry and Machine Co. 214
Post-Glover Electric Co., The 143

R

Ramtite Co., The 59
Rockwell-Standard Corp., Universal Joint Div. 190
Rust Furnace Co., The 135
Rust-Oleum Corp. 10, 11

S

SIEMAG Siegener Maschinenbau GMBH 5
Spectrochemical Laboratories, Inc. 161
Spraying Systems Co. 57
Square D Co., Electric Controller & Manufacturing Div. 38, 39, 185
Stamco, Inc. 189
Steel Equipment Co. 198
Stewart-Warner Corp., Alemite Div. 173
Surface Combustion Div., Midland-Ross Corp. 46, 172

T

Tapecoat Co., The 180
Taylor Chain Co., S. G. 208
Taylor Instrument Cos. 204, 205
Timken Roller Bearing Co., The 58
Tool Steel Gear & Pinion Co., The 48, 49
Torrington, Co., The 145

U

Union Carbide Corp., National Carbon Co. 34, 35
United Engineering & Foundry Co. 29
United States Steel Corp. 178, 179

W

Wagner Electric Corp. 30
Waldron-Hartig Div., Midland-Ross Corp. 161
Wall Colmonoy Corp. 57
Wean Engineering Co., Inc., The Cover 1
Wellman Smith Owen Engineering Corp. Ltd., The 174
Westinghouse Corp. 53, 54, 55, 56
Wheelabrator Corp. 14
Whiting Corp. 165
Wilson Engineering Co., Inc., Lee 4

Y

Youngstown Alloy Casting Corp. 36
Youngstown Foundry & Machine Co. 156
Yuba Consolidated Industries, Inc. 138

POOLE Flexible Couplings

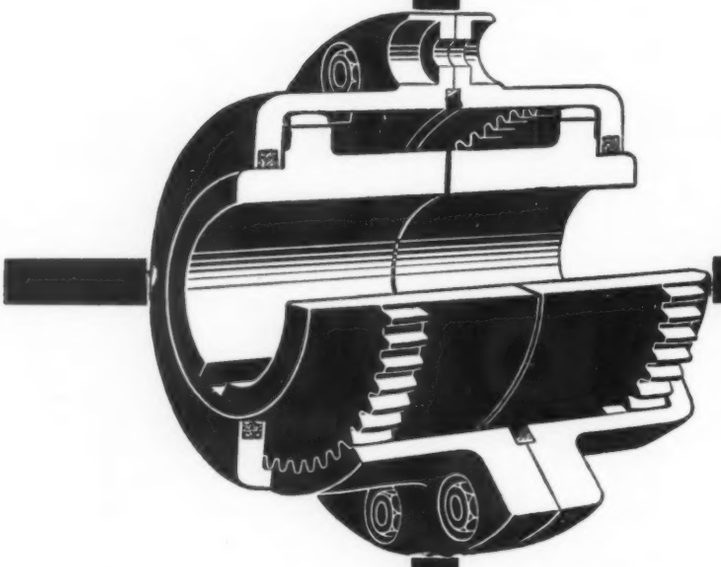
Look at these features—many of them exclusive with the patented POOLE.

Adjusts itself to all conditions, leaving its members free to float without strain to parts.

Geared type providing great strength, the highest efficiency of modern flexible coupling design.

No flexing materials to crystallize or break . . . No welded parts . . . Filled with oil, self-lubricating . . . Oil tight, dust tight . . . Permits free lateral float . . . Stronger than shafts it connects . . . Compensates for both off-set and angular misalignment.

Steel mill drives equipped with POOLE FLEXIBLE COUPLINGS



Get the whole story from our handbook, "Flexible Couplings." A copy will be sent gladly without obligation.

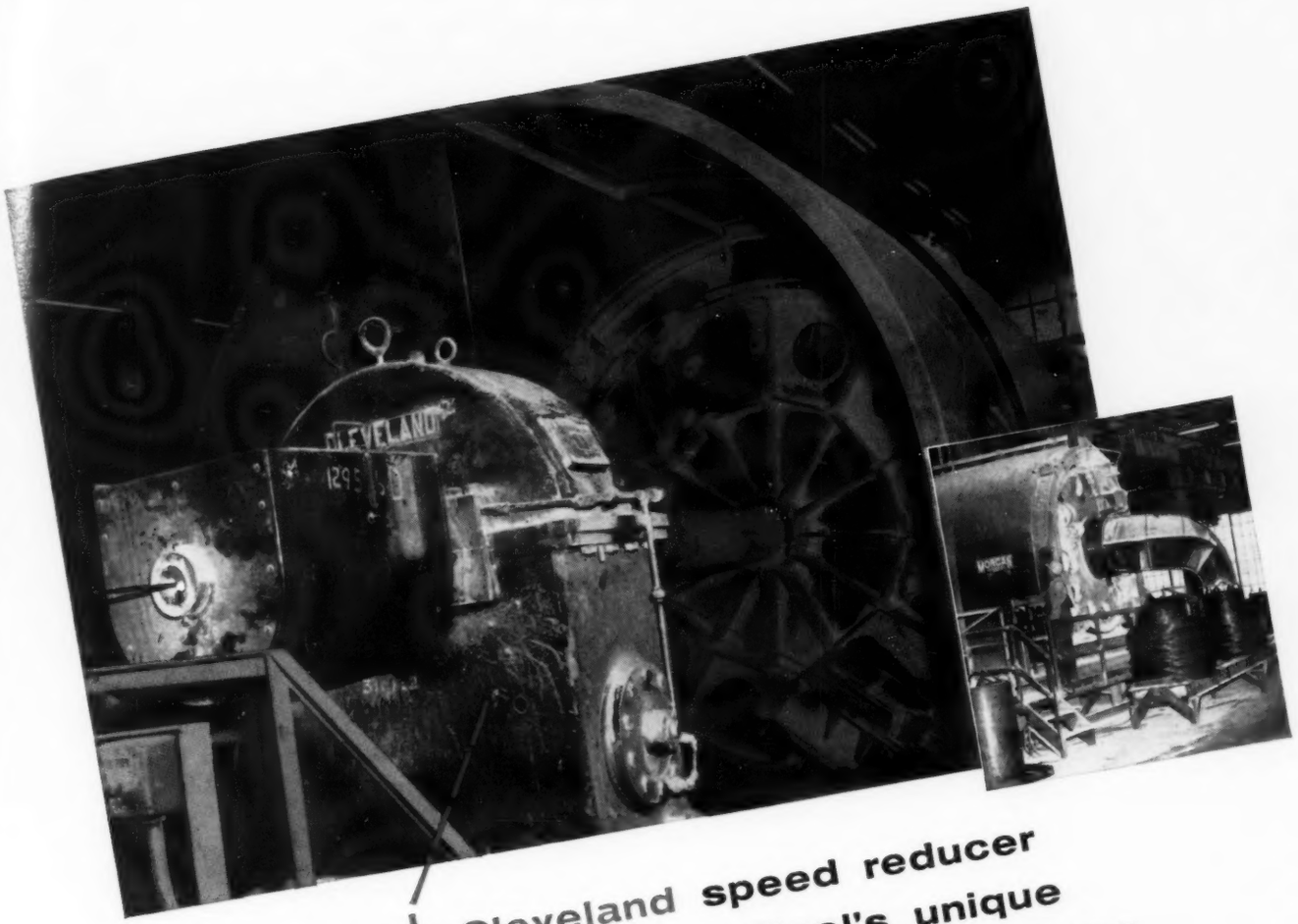
the better

FLEXIBLE COUPLING

POOLE FOUNDRY & MACHINE COMPANY

1700 UNION AVE.

BALTIMORE 11, MD.



This versatile Cleveland speed reducer smoothly drives Sheffield Steel's unique stationary bull block wire drawing machine

Here's a Cleveland-driven wire drawing machine, made by Morgan Construction Co., that draws wire up to .670" at an operating efficiency better than 90% — as compared to 40-60% for conventional machines. Its stationary bull block feature makes the machine's operation practically continuous.

Incoming wire passes through a special hollow shaft that carries the gear in the drawing machine's large, heavy-duty Cleveland worm gear drive. This successful, proven installation at Sheffield Div. of Armco Steel Corp., Kansas City, Mo., is revolutionizing the drawing of large wires for boltmaking. Industry has found through experience that wherever a quiet, compact, right-angle worm gear drive is required, it's a job for a Cleveland—progressive pace setter in power transmission for over the last 47 years.

Talk over your current requirements with a Cleveland Representative today. Or, write us direct for your free copy of Bulletin No. 145 containing up-to-date engineering information.

Cleveland Worm & Gear Division
Eaton Manufacturing Company
3278 East 80th Street • Cleveland 4, Ohio

EATON®

CLEVELAND
Worm Gear
Speed Reducers

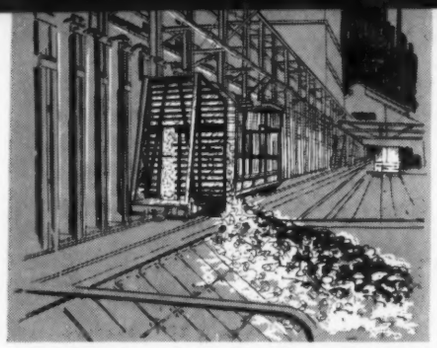
HARBISON-WALKER ACHIEVEMENTS WITH REFRACTORIES

for steelmaking progress

Among the several hundred different Harbison-Walker brands of various kinds of refractories are the many which were developed by research, introduced and proved in service, specifically to meet the needs for the unprecedented progress in iron and steelmaking. Some are on the threshold of successful accomplishments and others retain established records with the original "breakthrough" now left far behind.

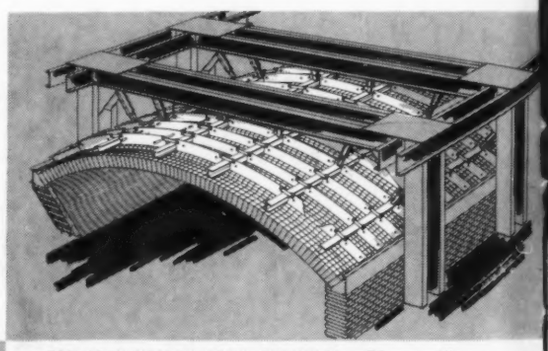
These refractories serve every phase of the industry. Included are those for furnaces used in ore beneficiation, for coke ovens, blast furnaces and for the various steelmelting and heating furnaces.

Some of the more prominent Harbison-Walker brands are listed with the application drawings on this page.



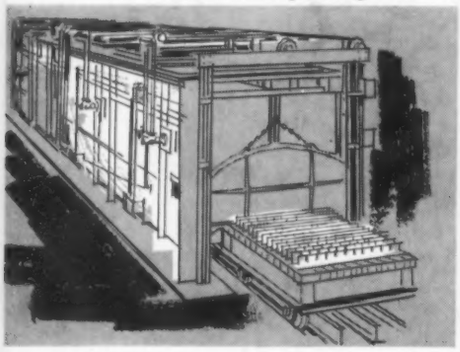
FOR BY-PRODUCT COKE OVENS—STAR silica and all the alumina-silica refractories in modifications for the precise needs, developed and established through many years.

FOR BLAST FURNACES AND STOVES—KAOSIL the unique semi-silica fireclay brick; VARNON BF and H-W 18 brands which have maximum immunity to the effects of carbon monoxide and to other destructive factors; Harbison-Walker castables for monolithic constructions.

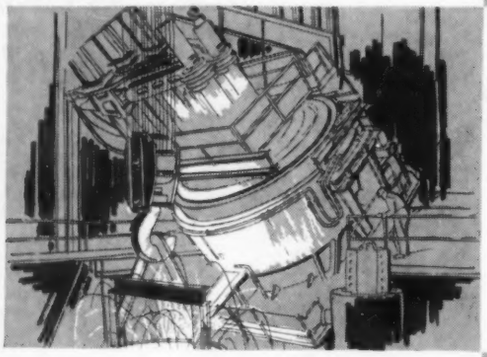


FOR OPEN HEARTH STEEL FURNACES—VEGA the original superduty silica brick and VEGA HP of exceedingly high spalling resistance for hot patching; H-W C-MIX and H-W MAGNAMIX for contour-formed monolithic bottoms; FORSTERITE L regenerator checkers; METALKASE MAGNEX OHR XXP for basic roofs.

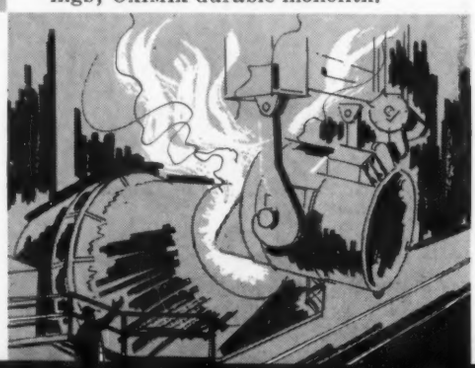
FOR HEATING FURNACES—All classes of high-duty, superduty and high alumina refractories. H-W 23 LI brick—high strength, insulating value and immunity to controlled atmosphere gases.



FOR ELECTRIC FURNACES—All the leading basic brick and monoliths—H-W PERIKLASE; METALKASE; H-W C-MIX; STAR and VEGA silica brick; CORALITE and H-W MULLITE plastic refractories.



FOR OXYGEN VESSELS—OXILINE brands for working linings; OXIBAK for fixed linings; OXIMIX durable monolith.



HW 60-21-A

Harbison-Walker Refractories Company
AND SUBSIDIARIES
World's Most Complete Refractories Service
General Offices: Pittsburgh 22, Pennsylvania